Second Edition American Malacological Union.

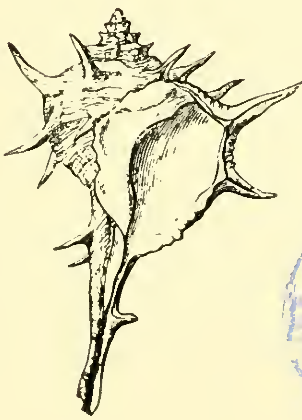
HOW TO COLLECT SHELLS

A Symposium

A Publication of the
American Malacological Union

HOW TO COLLECT SHELLS

(A SYMPOSIUM)



Publication of

THE AMERICAN MALACOLOGICAL UNION

1961

FOREWORD

In 1941, a portion of the annual meeting of the American Malacological Union was given over to the reading of papers covering various methods of collecting mollusks. Printed in the annual report bulletin for that year, these papers made up a handy reference manual which was in great demand among collectors and students. The supply was soon exhausted, but the demand has remained so constant that it has been decided to republish these papers. Many more articles, dealing with fields which the earlier report did not cover, have been added.

Since this booklet is in the main a compilation of material which has appeared in publications other than the above, the gratitude of the American Malacological Union must be extended over a wide range. Especial thanks must go to *The Nautilus* which has been drawn upon so heavily, and to the publishers of *American Seashells* which provided two interesting articles. Other sources from which material is being reprinted include *Turtox News, Mollusca of the Niagara Frontier Region, Shell Notes, Science, The Cornell Veterinarian, Mollusca, U. S. National Museum Bulletin, Land Mollusca of North America, Chicago Museum of Natural History Bulletin,* and the *Limnological Society of America.*

And finally, a debt must be acknowledged to those persons who gave of their time to write articles especially for this manual. In sharing their knowledge of specialized collecting, they uphold the major purpose of the American Malacological Union, that of promoting the science of malacology through the cooperation of its members. If this booklet is useful to malacologists on any level, the existence of the organization will have been justified.

Publication Committee:

R. Tucker Abbott
George M. Moore
Jeanne S. Schwengel
Margaret C. Teskey

March 31, 1955.

How to Collect Shells has been in such demand that it had to be reprinted several times. Friendly critics have pointed out that some topics were not sufficiently covered and that some of the information in the first edition was now out of date. It is now desirable also to add new information, for example on shell books and shell clubs, hence this new edition. The material of the first edition has been re-arranged for easier reference, duplications have been eliminated as much as possible, and new material has been added. The undersigned will be glad to hear about misprints, errors, and suggestions for later editions.
March 1, 1960.

Aurele La Rocque

INTRODUCTION

No handbook of instructions for shell-collecting can speak with more authority than this official publication of the American Malacological Union, for it contains a wide variety of advice from the leading authorities in this country. Both professional and outstanding private collectors, all members of the society, have contributed the sum of their many years of profitable collecting and preparation of shells.

This booklet will stimulate the interest of the novice who is sometimes plagued by problems of how to collect and how to clean shells, and many students who consider themselves advanced in malacology will find themselves turning to one section or another for information.

The hobby of seashells has no bounds, and the mollusk enthusiast need only be careful that his "shell-shocked" condition does not become chronic. Shells have a natural attraction as objects of beautiful design and exciting colors, but they become even more fascinating if one wishes to sort and identify the various species, or, if one is handy with the hands, make shell jewelry. The studious type may wish to pursue the historical lore connected with shells, and his studies may take him into the realm of archaeology, the history of religion or ancient commerce. Those who have a natural bent for biology and the mysterious ways of nature, will delight in learning fascinating facts about the life history, manner of feeding and reproduction of the common snails and clams.

And do not think that living near the seashore, or limiting one's interest to marine shells, is necessary to pursuing the hobby of the collection or study of shells. Some weird and interesting shells await the observant collector who searches in backyards, nearby woodlands and local ponds. No matter where you turn, mollusks are not far away, and offer unlimited horizons of entertainment. You need only read the late Dr. Frank C. Baker's instructions concerning fresh-water shells to realize that seashells are only half the story.

A further word about the American Malacological Union—it is a sturdy and ever-growing band of people who are interested in shells, and open to anyone who seeks the elusive mollusk. Its membership includes zoologists from leading universities and museums, and not a small number of beginners. The annual meetings and the monthly sessions held by the several local clubs in as many parts of the country afford an opportunity for shell enthusiasts to exchange information on mollusks, to exchange shells and to know each other. But whether or not you join, you will find its members always willing to help you increase your case of "shell-shock."

R. Tucker Abbott,
Pilsbry Chair of Malacology, Academy of Natural Sciences, Philadelphia

CONTENTS

The American Malacological Union is a scientific non-profit-making organization dedicated to the study of mollusks and their shells. Any interested person is welcome to become a member. There is no initiation fee and the annual dues are nominal. For information address:

Mrs. Margaret C. Teskey, *Secretary-Treasurer*

AMERICAN MALACOLOGICAL UNION
Route 2, Box 318
Marinette, Wisconsin

COLLECTING MARINE SHELLS

SHORE AND SHALLOW WATER COLLECTING

By B. R. Bales, M.D.

Reprinted from 1941 Annual Report, American Malacological Union, in part, and from "Shell Notes" (Vol. 1, 7 and 8), 1944.

In no other form of mollusk collecting is there need of so many different tools or implements, and, while a student may achieve a measure of success with no equipment whatever, he will eventually find that many specialized tools will be necessary as he progresses in the study of marine malacology.

Hook. Probably the most useful tool, and one that will be used day after day if given a thorough trial, is a hook made from 5/8″ metal. This hook should be of a length convenient to the collector's needs and should be the same length as a walking stick. Any blacksmith will make one. The point should be sharp, and a handle should be made at the other end by bending the metal into a loop or hand-hold. Three or four inches above the point, a curved hook, also pointed, should be welded on so that the finished product is in the form of an elephant hook with an elongated handle. This tool is conveniently used as a cane when walking the beaches; is handy to turn over shells or small rocks seen through the water-glass or to turn over shells on the beach without stooping; may be used to draw objects to the collector; is fine for a snake weapon when hunting in the jungle or hammock; may be used effectively to bring down a branch on which a Liguus is resting to convenient reach, and is an all-round efficient tool. Be sure to paint it red, orange or other brilliant color so that it may be readily found should it be dropped in water or jungle. Hooks soon become rusty and the color blends with soil or sand, but if painted, they are readily located.

Screen. To collect the smaller specimens from shallow water, it is often necessary to use a screen, and these may be made in many sizes and forms. If an oblong screen is used, it should be not less than 22 inches long and 12 inches wide; if it is a square one, 18 inches will be found convenient. The sides should be from 3 to 5 inches in height. However, the size of the screen depends upon the individual user, and it should not be so large that it taxes the strength, for it should be remembered that to be successful in screening, the collector must be persistent and many hours are usually spent in this manner. It is a fascinating form of collecting and the time flies all too soon. Seldom will the collector stop sifting without trying "just one more screenful" of material. Some collectors prefer several graduated sizes of screen wire cloth, but most prefer just two; the inside screen to be 1/4 inch mesh and the outer one of 1/8 inch mesh. The inner screen

with the larger mesh should fit snugly into the outer one with the smaller mesh, but not too snugly, as allowance should be made for the natural swelling of the frames, although much swelling will be avoided by painting the frames. Some collectors nail a small cleat to the ends of the outer screen to obtain a firmer grasp, or the same results may be obtained by sawing a narrow horizontal slit in the end of the frame. The size of frame and mesh being of individual preference, it is sometimes advisable to try out several before the ideal one is found, and even then, many collectors change from time to time as the occasion demands.

One form of screen that is sometimes used has no upright frame on one side and is held in place on the ocean floor by the collector's foot. The sand, mud, marl or other material, is raked or drawn into the screen by the use of a hoe, rake or other utensil. This overcomes lifting the material and depositing it in the screen. To fill the screen with material, various tools are used, such as a trench shovel, and a sheet iron cylinder with a hand hold riveted to the side, a hoe and even a tin can.

Water Glass or Bucket. An important adjunct to shallow water collecting is the water glass or water bucket. The original of this device is the bucket with a glass bottom used by sponge fishermen. Collectors adopt the same principle, but use one that is square or oblong. An easy way to construct one is to make the frame or box of not too heavy wood and fasten the glass to the open bottom by means of quarter rounds available at any lumber yard. These should be coated with white lead before nailing on to make it water tight. The inside should be painted a dull black. When in use, frequent wetting of the inside of the glass makes vision clearer and an occasional application of Bon-Ami will brighten up the glass wonderfully.

Forceps. While collecting small species, a pair of spring forceps is a necessity, for small shells like *Caecum, Rissoina, Cerithiopsis,* and the like, are too small for the fingers. Be sure to have a string tied to the forceps, and fasten the string to some part of your clothes, and have sufficient length of string to permit free use of the forceps. Being small, forceps frequently are lost and prudent collectors (especially if they have lost a pair or two) never fail to use a string.

Thread Cops. One of the most useful things to have in the collector's kit is what is known as "cops." This is a compact roll of rather loosely spun cotton thread, and thousands of yards are contained in a single roll. It may be obtained from any dealer in collectors' supplies. For holding bivalves together, for tying small Chitons to drying boards and in many other ways it will be found handy and inexpensive.

Small Hooks. Hooks useful in drawing the bodies from small shells may be made by whittling small cylindrical handles from some soft wood, making them 3 or 4 inches long and the diameter of a lead pencil. Into this handle push a needle (with the eye downward), leaving the point out. This point may be bent to any degree of curvature by heating over a Bunsen burner and bending while white hot. Some collectors achieve excellent results while using a piece of the fairly stiff springy wire used as

a leader on fishing lines and there are many beautifully prepared specimens where the only tool used was a safety pin with the point bent into a hook. Many collectors use hooks on but few occasions but resort to the use of a syringe to clean out the shell. The best syringe to use is the one used by dentists and is of the piston type, but the common rubber ear syringe may be used. This does not give nearly the amount of force, but is much less expensive.

Rake. A useful device for collecting Cyphomas consists of a child's toy rake, to be obtained at any ten cent store. The teeth of the rake are bent inward on a curve and a small piece of screen wire attached at each side and at the back, thus forming a sort of basket with projecting teeth. By bringing the hook under a strand of Gorgonia on which a Cyphoma is resting, it may be hooked or scraped off and falls into the basket. By attaching a long handle to this device, it may be used from a boat in deeper water.

Paper Plates. A supply of paper plates should always be on hand for convenient drying of specimens.

Crochet Needle. For removing the bodies from the larger Conus, it has been found that a common crochet needle is useful. The end should be slightly bent.

Rock Dwellers. A malacologist in quest of rock dwelling mollusks bears no resemblance to the ordinary collector. His equipment consists of a chisel or two and a hammer. This is the visible equipment. The other 50 percent consists of either superhuman control of his speech organs or a vocabulary that would make the ordinary mule driver green with envy. After all, it *is* exasperating to carefully remove rock surrounding a burrow of *Botula fusca*, bit by bit, using the greatest care until the prize is almost within reach, when a glancing blow of the hammer shatters the specimen. Any sort of explosion is justified, for this sort of thing happens all too frequently.

Usually the entrance to the burrow is in a more or less protected part of the rock near the water's edge, so the collector must assume all sorts of unusual and awkward positions while working. The entrances to the burrows of the various mollusks that live in the rocks are as variable as their owners. *Lithophaga antillarum*, *L. nigra*, and *Botula fusca* have entrances that are oval in shape. On rare occasions, when covered with water, the mantle of the mollusk may be seen at the entrance, but the usual procedure is to search for the entrance and to investigate every promising hole in the rock.

With *Lithophaga bisulcata* the entrance is perfectly round and surprisingly small when compared to the size of the mollusk. At times the tip of the shell may be seen at the burrow's entrance. The burrows of all the foregoing are of the same shape as the shell they conceal. *Gastrochaena ovata* and *G. cuneiformis* construct a pair of short perpendicular tubes of shell substance at the entrance of the burrow. Once found, these are very conspicuous, but it is surprising how many of these "signs" are overlooked.

The burrow extends into the rock for quite some distance and may turn in various directions before the bottom — some four or six inches away — is reached. This adds to the difficulty of removing the mollusk undamaged, as the collector is never sure as to just where the shell lies. Many specimens are shattered.

With *Gastrochaena rostrata*, the cylinders emerge from the rock, side by side, at that point the tubes turn and the openings point in opposite directions and are horizontal instead of vertical as in the other two. The burrow of *G. rostrata* lies but a short distance beneath the surface of the rock and the shell is not nearly so difficult to remove as the others. This is fortunate as it is the rarest of the Florida Gastrochaenidae.

There is no difficulty in locating the burrows of *Rupellaria typica* or *Petricola lapicida,* as they lie close to the surface of the rock. Usually the black tips of the siphons are visible and resemble a colon punctuation mark.

Most collectors of the rock dwellers try to preserve a portion of the rock at the entrance of the burrow to accompany the shell in the cabinet, thus adding interest to the specimen. With *Lithophaga*, this is not a difficult matter, but fully one half of the *Gastrochaena* cylinders are broken while removing the shell.

Coralliophaga coralliophaga is frequently found in a *Lithophaga* burrow. During several winters spent in shell collecting among the Florida Keys I have taken alive the following species: *Lithophaga antillarum* d'Orbigny, *L. bisulcata* d'Orbigny, *L. nigra* d'Orbigny, *L. aristata* Dillwyn, *Botula fusca* Gmelin, *Gastrochaena cuneiformis* Spengler, *Rupellaria typica* Jonas, *Petricola lapicida* Gmelin, *Coralliophaga coralliophaga* Gmelin, and *Fundella candeana* d'Orbigny.

Bilge Pump. When the ocean floor is of rock that is more or less honeycombed, and with small pot holes, it is surprising what fine specimens of the small varieties may be obtained by the use of a common bilge pump which is standard equipment in small boats. The end of the pump is placed in a sand-filled pocket in the rock; the sand as well as the mollusks that have taken refuge in the hole are pumped with the water into a screen; the sand and water flow through, leaving the specimens all ready for the collector.

Sieve. A handy device often used consists of a small round sieve which has been attached to a long handle. They are easily made from a 5 or 6 inch gravy strainer to be had at most ten cent stores. They have two bent prongs in front which must be bent backward so as not to interfere with the use of the net. No device equals this when working in waist or chest deep water.

Rust. Freshly taken specimens should never be placed, even temporarily, in a rusty metal container or in contact with rusty chains or other rusty objects for it is remarkable how soon they will become rust stained, and it is almost impossible to remove this stain.

Traps. During the past few years, mollusk traps have been used to take many of the carnivorous mollusks and reports from those who have used them have been very optimistic. Some of the older collectors reported success with this type of mollusk by simply placing a piece of meat or a dead fish between two sheets of wire mesh and weighting them down with stones, overnight.

Night Hunting. To one who has never collected at night, hunting with the aid of artificial light is a revelation. Many mollusks that are rarely encountered in daytime may be simply swarming at night. This is particularly true of *Marginella, Cypraea, Hydatina* and the like. While specimens may be taken by the combined use of water glass and flash light, the ideal light is provided by a gasoline lantern whose asbestos mantle produces an intense white light. Two forms of these lanterns are being used and each has its advantages. The one with a single mantle is not heavy and gives a good light, but the lantern equipped with two mantles, though quite a bit heavier, gives a more brilliant light and also has a reflector which further increases its efficiency. The collector who has never collected at night has a thrill in store for him.

Tide Tables. To attempt to do much shallow water collecting without first consulting the Tide Table would be the height of inefficiency, for all collecting of this type is dependent upon tide conditions, and where there is excellent collecting at a given place at low tide, it would be simply out of the question to do any worthwhile collecting at high tide. For collectors in the east, Tide Tables of the Atlantic Ocean and for western collectors, Tide Tables of the Pacific Ocean may be obtained by writing the U. S. Department of Commerce, Coast and Geodetic Survey at Washington and enclosing 25c for the Tide Tables of the current year. No active collector can afford to be without his tide table and it is confidently asserted that if most collectors would read their Bibles as frequently as they consult their tide tables, they would be more nearly spiritually perfect.

Game Bag. Probably as important a part of the collector's outfit as any is his game bag, and this may consist of almost anything from an old tin can, a salt sack, a pocket handkerchief or some such makeshift affair, to a real game bag. They are usually made from light canvas and carried in some cases by a strap over the shoulder. Such bags are useful when extra heavy specimens are anticipated, but it is found that a bag that may be tied or secured about the waist is much handier and has the advantage of always being in place and does not drop in front of the collector when he stoops to secure a specimen. Many collectors favor a bag having a dividing partition. In one compartment may be carried tools, vials and other equipment apart from the shells that are collected.

Jars. There are other methods of "bringing them back alive." One active and very efficient collector uses a wide-mouthed flat bottle, such as a pickle bottle which he carries in his hip pocket. The bottle is filled about one third full of water which acts as a cushion when shells are dropped into it. The bottle is not removed from the pocket at any time while col-

lecting, is in an upright or semi-upright position at all times and can be carried open without spilling. This method is used for such shells as are too large for the vials and too small to be mixed with the larger ones in the game bag. It is a very convenient procedure, especially while sifting when both hands are busy with the screen.

Vials. When collecting the smaller mollusks, it is convenient to be provided with a number of small vials. These should be cylindrical and of the screw top sort without a narrow neck. Many medicines come in this sort of vial and there should be no trouble to secure a supply.

Bucket. When collecting *Barnea costata, Ensis directus* and possibly other similar bivalves, it is well to have a bucket of sea water at hand in which to place the specimens as soon as secured, for it is not uncommon for these to contract their muscles with such force as to fracture the shell. Placing the specimens in water immediately seems to overcome some of this, but even when all precautions are taken, some are broken in this manner.

Switches. As *Barnea costata* is usually found in colonies, very frequently where there is a mud bottom, digging out the first specimen or two causes the water to become so muddy that further collecting is out of the question as the burrows cannot be located. In such cases, a good plan is to secure a supply of small switches from some nearby trees and place a switch in each burrow as it is located and not to start digging until all desired burrows are marked; then the collector may proceed from one switch to another and be able to locate as many specimens as he desires to collect.

Conservation of Habitat. Before leaving the subject of collecting, it is well to emphasize one point that possibly does not come within the scope of this paper, but shell students should be impressed with the fact that they should leave the ocean floor or wherever they have collected as nearly as possible in the same condition as when found. Nothing indicates the thoughtlessness of a collector more than to follow in a day or two or frequently months where someone has recklessly turned over rocks, leaving their bare and bleached portions exposed where it will take many more months for them to be covered by the natural growth necessary to the maintenance of molluscan and other marine life.

SUGGESTIONS FOR WEST COAST MARINE COLLECTING

By Elsie M. Chace
Lomita, California

Tide Book. The first necessity in planning a collecting trip is to obtain the tide book published annually by the U. S. Government. The small ones given away by sporting goods stores are good, especially in that they call attention to regulations governing bag limits, local closed areas, etc. However, because of the northwesterly trend of our coast the tide time varies too much to make them dependable for more than local districts.

License. If you plan to collect live shells in California, obtain a California fishing license. It is definitely required for abalone, cockles, and several other things; a law recently enacted might be interpreted to cover *everything*. Sorry if this seems inhospitable to visitors, but it is the law.

Collecting Hints. Some unrelated facts: the northern shore of a rocky cove frequently offers better collecting than the southern. Except when a storm has thrown things up, a black sand beach is apt to be barren. On few west coast beaches may shells be found in windrows (as I understand occurs in Florida) but occasionally a strong on-shore wind will put interesting specimens on the sand.

Sandy bay collecting seems to offer more varied species than rocky coves, and summer collecting is sometimes highlighted by numbers of a single species in to spawn. Morro Bay, California, in July has yielded *Acteon punctocaelata, Calliostoma canaliculatum* and *tricolor;* other bays have their own annual visitors.

No need to wait until extreme low tide; the intriguing trails made by *Natica, Bulla,* some *Murices* and *Olivella* may be spotted and the makers reached through several inches of water. Burrowing clams (*Panope, Schizothaerus, Tagelus,* etc.) can also be so located, though digging is best left until they are uncovered. But *Drillia, Terebra, Sinum* and some bivalves may be entirely hidden while the tide is lowest, popping out of the sand shortly before the flat is to be covered by the incoming tide. *Mactra* sometimes shoots several inches above the surface. Screening for small *Tellens, Thracias, Epitoniums,* etc. in the top two inches of mud flats is frequently profitable. And sometimes it pays to dig *Natica* out though you do not wish to take it; it may be working on a clam that you would find in no other way, and its trails and bumps are not easily distinguished from those of *Sinum.*

Along rocky shores examine the roots (holdfasts) of washed-up kelp for many things which live far below the low tide line. And look for *Haliotis* under overhanging ledges and in crevices; the picture postcards which show four or five big abalones clinging, partly on top of one another, to the side of a rock surrounded by sand belong to the department of humorous fiction. They just don't live that way. The traditional story of someone trying to pull an abalone off a rock, being held fast and drowned by the incoming tide has not been verified, but one could certainly get smashed fingers. Use a tire iron or piece of automobile spring to pry them from the rock, but never reach under a rock without looking, for the Moray eel may live there, a savage fellow who can slash through the thickest glove. And finally, know the bag and size limit on abalones; young shells may never be taken without special permit, and the bag limit varies.

Special Habits. A red "sponge" on the rocks of the Washington coast gives food and shelter to *Velutina* and some *Lamellarias,* while farther south a yellow "sponge" shelters a little *Cerithiopsis* while another is food for *Tylodina fungina.* The latter usually hangs shell down.

A *Pleurobranchus* has been taken under stones at mid-tide near Crescent City, California; field experience is the only guide in separating it from its white nudibranch neighbors. *Pedipes* and *Truncatellas* live close to high tide line on decaying eelgrass, a foot or more down in the rubble. On the Mendocino County (California) coast the orange-colored animal of *Fusinus harfordi* distinguishes it from white-animaled *Searlesia dira* much more quickly than the shape of the shell. *Opalia insculpta* (*O. crenimarginata*) usually lives in sand around the base of a solitary anemone. The more northern *O. chacei* seems to be a mid-tide shell, sometimes in sand-floored runways between ledges, again, especially in northern California, in tidepools around purple sea urchins; live shells are apt to look gray-green. *Epitonium tinctum* lives among anemones that grow in sheets covering the upper surface of rocks; some collectors find that running their fingers through these masses causes their hands to become sore.

Commensals. Melanellids are commensal; I have taken a few on a big "sea lemon," but they occur in quantity in the sand beneath a little white "sea cucumber" which in turn lives in hollows in the ledges near Crescent City. *Vitrinella oldroydi* and *Serridens oblongus* live on or under large *Ischnochitons.*

Mussel colonies. The masses of *Mytilus californicus* that grow on pilings or rocks frequently yield interesting shells of other species; various *Odostomias, Entodesma saxicola* and *Mopalias* of certain color patterns are frequently so found on northern rocks. An occasional *Lamellaria sharonae,* a small pink form of *Venerupis staminea, Odostomia,* and *Isapis fenestrata* (long thought to be scarce) are more apt to be found among the southern mussels. Because of the so-called red tide the law forbids using either mussels or clams for food or bait during the summer months, so one should be prepared to convince a game warden that only specimen shells are being taken.

Limpets. *Acmaeas* are plentiful on our coast, and their specific variations and apparent intergrades are frequently described as a short cut to insanity; where and how they live often helps to identify them. *A. triangularis* lives on coarse coralline at Pt. Pinos; *A. ochracea* is apt to be on small stones in the tidepools which do not go completely dry. Superficially it resembles both *A. patina* and *A. limatula,* but the former is larger and lives higher up on the beach, while the latter, also larger stays closer to tideline, and is rare in the more northern range of *A. ochracea. A. instabilis* has a very definite situs, the stem of one certain kelp; and watch for the prettily-marked young. A tide of minus one foot is usually needed for this species, or a swim suit and mask. It is not found south of Monterey. *A. incessa* has its own ecologic niche, the long midribs of a *Fucus;* sometimes the same plant will have *A. incessa* on the long floating ribbons and *A. pelta* on the holdfast. *A. persona* seems to prefer shaded spots.

Shell Clubs. Finally: try to get to a shell club meeting. That is the best place to meet local collectors who will gladly supplement these suggestions and help identify previous finds. Meantime, good hunting!

Screening Methods. Recently, while on a trip to the Florida Keys, I decided to try screening a likely-looking place; upon trying a rake I found that method useless. Then I tried the back of the rake, but found that the sand was so thin, about one-half inch, on a fairly smooth rock floor that not even a hoe would work with any degree of satisfaction. Then I tried fanning the sand onto the screen with a little paddle made of a scrap of drift wood. It worked so well that I doubt that I shall ever use another method on such a bottom. The sand from the smooth rock is swept in with ease by a long lazy stroke of the paddle, and the sand from the little pits and crevices also sweeps into the screen. Use a screen of one-eighth inch mesh. Later I tried this in a very soft muddy bottom where raking only brought in soft gobs that were most difficult to wash through the screen; the results were more satisfactory than any tried before on such a bottom. So I tried it again on a grassy bottom, and it worked here also. Try it!—FRANK LYMAN, *Shell Notes,* Vol. 1 (8)

A Tip for Tidepool Collecting. The most obvious method of collecting elusive organisms from tidepools is to remove all the water, but not many collectors carry along a pump or lengths of hose for siphoning. Along the Pacific Coast, however, nature has provided a natural substitute for hose, the hollow stipes of kelp (*Nereocystis* and *Macrocystis*). Short lengths of these stipes, which can usually be found cast ashore, are filled with water and one end is lowered below the level of the pool. This quickly siphons out the water, especially if several pieces are used. These siphons can empty quite a large pool if one starts them at the beginning of a field trip and makes the pool a last stop. Of course some of the animals will hide far back in crevices but a pair of "mechanical fingers" obtainable at any auto supply store will soon ferret them out.—EARL T. WALKER, *Turtox News,* Vol. 31 (6), June, 1953

Collecting Tip. A common wash tub is a good thing to take along when collecting in water not exceeding five feet in depth. Simply tie it to your waist with a very stout cord and in it place your shell jars, smokes, lunch, tools, etc. Then tow it about wherever you go with your waterglass. A bottle of household bluing should be along if you are in the territory of Portuguese Man-O-War, for in case of a sting it is a most effective medication.—FRANK LYMAN, *Shell Notes,* Vol. 1 (14)

Collecting Planktonic Shells. Anyone can collect planktonic shells. If you tow a cone-shaped net made of any smooth, fine-meshed cloth behind a boat you will be amazed at what you catch. Rig your net on a stiff wire loop a foot in diameter, tie three bridle lines to this and you have it. Tow at about 2 or 3 knots for 10 or 15 minutes, then haul it in and carefully turn the net wrong side out and wash the contents into a jar. If you do your hauling at night you will get much more. If you haul out in the open ocean you may get Pteropods, interesting gastropods that are not larvae at all but interesting shells that spend their entire life in the

plankton. They are shaped like ice cream cones, anchors, left-hand spirals and many other odd shapes. Some may be an inch long.

You may get larval *Cypraea*, called "*Echinospira* larvae." They are beautiful spiny, glassy, clear, flat coils, with the baby embryo tucked deep into the spiral. Compare the right-handed larvae with the protoconchs you find on adult shells and you may be able to identify them, at least to genus.

To preserve your planktonic shells, add some alcohol or formalin to the entire haul. When everything has died, the shells will settle to the bottom and you can carefully pour off the lighter animals. It is not practical to remove the animals from the shells, so keep them in a small jar with 50 percent alcohol or very weak formalin. Add a pinch of borax or soda to prevent acid from forming.—HAWAIIAN SHELL NEWS.

Collecting Minute Mollusks from Marine Algae. Many minute mollusks live in marine algae rather than in sand. Instead of sorting through sand for beach-worn specimens it is often much more worth while to collect the animals alive directly from algae. Though some minute species live only in sand rather than in algae it does not seem to be generally realized how few actually do.

Mollusks show a certain amount of specificity to different kinds of marine plants. Filamentous green algae that form turfs, such as *Cladophora* and *Cladophoropsis* in the tropics and subtropics, support a large and varied fauna of minute species as well as juveniles of others which survive only elsewhere as adults, like *Pinna*. In the West Indies various red algae in the genus *Bostrychia* (= "*Amphibia*") are abundant on mangrove roots and support a distinctive assemblage of species, many of which seem not to live elsewhere. In temperate seas certain mollusks live only on large brown algae like *Fucus*. Gulfweed (*Sargassum*) also supports a rather distinctive but small group of species. More examples could be given, but these will indicate the kinds of algae which should be examined when collecting mollusks.

A distinct group of species is usually also to be found on the leaves of marine "grasses" such as *Zostera, Thalassia, Cymodocea, Ruppia,* and *Posidonia*. The snails often do not feed on the leaves themselves but rather on the epiphytic algae and other growths.

To collect the mollusks several handfuls of algae (or "grass") should be placed in a bucket and pulled apart into little pieces. Then the bucket is filled with *fresh* water. Most of the mollusks will drop to the bottom, leaving only some of the byssally attached clams. The pieces of algae near the top of the bucket are removed piece by piece, then the water is slowly poured off so as to leave only the residue in the bottom. More water is added and the process is repeated until the residue is fairly free from algae and detritus. The residue, although it looks unpromising, is then put in a small dish of *sea* water to revive the mollusks. If a microscope is at hand the collector using this technique for the first time will probably be sur-

prised at the number and variety of mollusks which will be seen crawling about, along with other animals (notably Foraminifera). The water in the dish should be gently swirled around so that the material settles near the center. As the oxygen content of the sea water is decreased, many of the mollusks, including some of the small clams, will crawl to the edge of the dish and cluster at the surface. This is the best means of separating most of the live animals from the sand grains and detritus at the center of the dish, but there are always some which do not crawl to the edge. Those at the edge may be picked up with a small brush and placed in one vial of alcohol and the remaining material may be put in another. In this way part of the mollusk sample is already separated without sorting. A portion of the alga from which the sample came should, ideally, be pressed so that it can be identified by an algologist. In this way more data will accumulate on the degree of specificity of mollusks to algae.

If little time is available in the field, as is usually the case, and if the collector cannot take a microscope with him, algae can be collected in jars to be pulled apart and washed with fresh water later, for the mollusks will stay alive for a number of hours. The residue from the bucket can be put directly into vials of alcohol. A few minutes spent gathering algae will often result in many hours of sorting afterwards with a microscope.

The writer has collected species of the following genera in great abundance in the Bahama Islands, using this technique: *Caecum, Rissoella, Amphithalamus, Assiminea, Lasaea, Musculus.* The following are scarcer: *Schismope, Pseudostomatella, Tricolia, Alvania, Litiopa, Triphora, Seila, Rissoina, Psarostola, Mitrella, Persicula, Marginellopsis, Odostomia, Pedipes, Carditopsis,* and *Papyridea.*—Robert Robertson, *Museum of Comparative Zoölogy, Harvard University*

Collecting in Seaweed Holdfasts. Seaweed holdfasts are a good collecting ground for marine shells that nestle or hide in the twisted mazes of kelp roots. Those that are torn loose from their rocky moorings and washed ashore after heavy storms often contain species that are rarely found, even by dredging.

On a number of different occasions when searching the offshore beds of the giant kelp (*Macrocystis*) in Monterey and Carmel bays of California with a rowboat, the attempt has been made to pull up the kelp by the roots. This is often impossible if the roots are well anchored as the stems usually break first. Sometimes, however, the attempt has been successful and the holdfast brought to the surface, often with a heavy boulder or slab of rock on which the kelp roots grew. In such instances the reward in shells collected from their roots and their attachment is usually worth much unsuccessful effort.

Once, while hopefully hauling on kelp stems to break one of the roots from its fastenings, one finally gave way and was brought to the surface from a depth of about 10 fathoms. It proved to be an unusually large and complete one, with a widespread tangle of roots nearly 4 feet in diameter and 2 or 3 feet thick. Along with the roots came several slabs and many

shattered fragments of shale. When cut from the stems this holdfast almost completely filled the boat so it was taken ashore and thoroughly searched for shells. The haul proved to be so rich that a record was kept, which came to a total of 53 species and about 440 specimens.—Allyn G. Smith, *Minutes, Conch. Club. S. Calif.*

Ever Try Sealed Beam Headlights? After one night of collecting this way, we are so sold on the idea that we plan to do it at least 3 nights each week. We use sealed beam car lights hooked up to a waterproof cable attached to a battery placed in a mesh basket in an inner tube. These really light up the water and do away with that feeling that something is sneaking up behind you in the dark.—Mrs. Jean Kauanui

A Trapping Idea. You may be interested in the shell traps used by the Mexicans to trap the pink Murex for commercial purposes. It is the simple old-fashioned automobile tire rim, over one side of which is stretched chicken wire or fish net, with ripe old shark meat tied in the middle as bait. Three wires around the rim, spaced equally, are brought together on top to form a simple bridle. A rope long enough to reach the surface is tied to this, and an airtight tin can to the other end to act as a float to mark the location. These traps were planted in the afternoon, pulled up next morning and 350 pink Murex were collected. The shells are too sluggish to escape while being pulled up; it is only necessary to avoid tipping the trap.—Crawford Cate

CLEANING MARINE SHELLS

By B. R. Bales, M.D.

Reprinted from 1941 report, American Malacological Union

After the mollusk is collected, the problem presents itself as to the best method of preserving it; and the ways are many and varied. A great number are cleaned by simply boiling them and removing the animal, but care should be exercised in bringing the animal out with a circular or corkscrew motion; in other words it should be twisted out and with larger specimens such as *Fasciolaria, Busycon,* and the like, an ice pick driven into the body will give a firm hold where it is most needed. Never boil too great a number of shells, other than bivalves, at one time, as the bodies are much more easily removed while hot, and shells that have been boiled and set aside for a time and have become cold are hard to clean because of the contraction or shrinking of the bodies. The liver and other soft parts are often left behind to make themselves very evident at a later time. Very few *Murex* and *Vasum* are perfectly cleaned, as they seem to have a weak connection between the muscular part of the body and the viscera; usually there is a break at this point when drawing the bodies, leaving portions that are next to impossible to remove. A few drops of formaldehyde introduced into the shells will eliminate bad odors. It is a good plan to plug the apertures with a wad of cotton for obvious reasons. When a crop of Janthinas is thrown upon the beaches and the bodies are still in the shells, it is well to place the specimens in fresh water overnight and the bodies

may be syringed out the following morning. Janthinas should not remain in fresh water for more than 12 hours, as a longer immersion will soften the periostracum in an irregular manner and the dried shells will present a blotchy appearance.

Removal of the body from *Xenophora* is almost impossible and boiling does not solve the problem. Frequently if the shell is placed with the aperture upward, the animal will thrust a greater part of its body out and it may be quickly removed, but in small specimens of this interesting shell, if a needle or pin is thrust through the body just back of the operculum and allowed to lie crosswise of the aperture, the animal will quickly die; then a small amount of formaldehyde introduced into the shell will preserve it.

For years it has been thought that no *Cypraea* should be boiled. It was thought that heating the shell would impair the gloss and the accepted procedure was to allow the animal to die and decay. The odor would be removed with many rinsings and the shell could eventually appear in respectable company. It has been demonstrated that the idea was fallacious and most collectors do not now hesitate to boil a *Cypraea,* but it has been recommended that the specimens be placed in tepid water and then brought to a boil, thus avoiding any checking of the shell due to sudden change of temperature. It is important after boiling the larger cowries that the shells be shaken vigorously to loosen the body of the mollusk and it should be shaken until the loosened body may be heard swishing about. All moisture should be removed from the shell as any remaining moisture will cause a bluish discoloration in the darker colored species and this discoloration is usually permanent.

With the larger *Cassis,* another procedure is necessary and this has been adopted with the larger *Fasciolaria, Busycon,* and the like. The shell containing the living mollusk is placed aperture side up for 24 hours or longer. The animal has usually become weakened by this time and a greater portion of it lies out of the shell. A stout cord or wire is tightly wound about the body, just back of the operculum, and then is tied to some convenient object so that the shell is suspended with all the weight pulling downward. Gradually the body is pulled from the shell by the shell's weight. A bed of soft material should be placed beneath the shell to prevent breakage and frequently the cord must be shortened from time to time as the body becomes more and more elongated from the constant traction.

A method of cleaning long in use by the Florida commercial shell collectors has recently been published, namely, the use of blow-fly larvae or maggots. This method, while repulsive, is very efficient and after a period of time, vigorous rinsing of the shell is all that is necessary.

Preservation by means of alcohol is usually adopted with many of the smaller species and many are placed in this preservative immediately, but it is well with the smaller operculate shells that they be allowed to remain out of water until death occurs and then placed in alcohol before decomposition sets in. By so doing, the opercula are preserved in plain sight.

Should these be placed in the preservative before death occurs, the animal retracts within the shell and the operculum cannot be seen in the prepared specimen. The specimens should remain in alcohol for at least 24 hours if small and longer if large. After removal, the fluid should be drained from them and they should be allowed to dry for at least a week before packing them away.

Larger bivalves, such as *Pinna, Arca, Lithophaga,* in fact all of the larger ones, should be boiled and the soft parts removed; even *Yoldia* and the smaller *Tellina* should be cleaned in this way.

There is a diversity of opinion regarding the position in which bivalves should be dried. Many favor closing the valves in a natural position and holding them in place by a few strands of cops wound about them until they are dry, but others prefer to dry the specimens, wide open, "butterfly fashion," maintaining that the beauty of the shell is enhanced and the inside structure more easily seen and studied. Individual preferences should be the guide.

If there is one procedure that will make the average collector use Biblical terms, loud and long, but in a different juxtaposition from those in Holy Writ, it is the practice of holding the valves in position by means of narrow strips of surgical adhesive plaster. The rubber coating of the plaster eventually separates from the fabric and adheres to the shell. It is hard to remove and the collector who adopts this procedure is roundly damned but NOT "with faint praise."

If it is desired that specimens of *Pteria, Anomia,* and the like be preserved on the Gorgonia or other object on which they have been found, they should be placed in alcohol for a day or two and then dried "*in situ.*"

Pododesmus should be left as found, as any attempt to remove the animal portions will prove disastrous. The animal is so small that it will not make itself unpleasantly evident and will dry up.

Dentalium, Rimula, and the like are left over night in fresh water and the animal easily removed the following morning. With *Cyphoma, Marginella, Oliva, Olivella,* and *Trivia,* it is necessary to kill the animal with fresh water. They should remain in fresh water for at least 48 hours, with two or more changes of water before the body is sufficiently softened so that it may be removed with the syringe. It might be mentioned that if the shell to be cleaned is held under water during the operation, the collector will obviate all danger of spraying his features and anatomy as well as all adjacent territory with none-too-sweet-smelling water.

The larger *Conus* may be boiled and the animal removed, using a straight wire or, as previously mentioned, a crochet hook which has been slightly bent. The wire should be introduced parallel with the long axis of the shell. A firm twist will usually start the body rolling out.

Be sure to preserve the operculum of every specimen and see to it that each shell has its own operculum. Place the operculum within the shell and close the aperture with a small wad of cotton or crumpled paper. Later,

when preparing the shells for the cabinet, a tightly fitting pledge of cotton wedged into the aperture will receive a drop of Duco on which the operculum is placed and pushed into position in a lifelike manner.

In case it is desired to preserve the specimens entire, alcohol has a decided advantage over most preservatives, especially when the animal is to be used for future dissection and study of molluscan anatomy. It is very easy to lose the identity of soft parts while preparing shells, so it is well to label each specimen at once. Ordinary bond paper on which the name is written with lead pencil is very satisfactory and may be affixed to the specimen with a short length of thread or string. These are usually thrown away, but many museums will be grateful for such material sent them. In this manner, the amateur collector may, in a small way, partially repay the large amount of free, unselfish, and efficient help given by these institutions.

Many collectors prefer specimens just as taken from the water, but many are more fastidious and try to enhance their beauty by cleaning off all extraneous matter. It is often surprising how much "beauty is only skin deep." Removing the periostracum often brings to light much hidden beauty. A common vegetable brush is useful in cleaning specimens, but if the offending growth is very persistent, a wire brush may be used. Many specimens will require still harsher measures. Where there is a quantity of coralline or calcareous growth, it is necessary to remove this bit by bit and very carefully so as not to injure the shell. A shoemaker's awl is a very efficient tool, but any sharp pointed instrument will do, including dentists' tools. Often it is necessary to use muriatic acid to remove these limy deposits and "thereby hangs a tale." What follows will be regarded by many as pure heresy and the advice is offered with a "take it or leave it" clause attached. There is no doubt that a certain amount of the delicate part of shell structure is injured by the use of acid, but if the collector is EXCEEDINGLY careful, very little damage is evident except by the use of a magnifying glass. Many fastidious collectors prefer the slight damage to the rough, uncouth natural specimen. Any advice regarding the use of acid should be taken only if the collector is willing to sacrifice certain portions of the shell structure. My method has been to use the acid, full commercial strength. The acid bath is close to a faucet of running water. The shell is held in forceps and quickly dipped into the acid and immediately into the running water. If necessary, another dipping may be tried and results noted. Often more chipping with the awl will remove a quantity of the lime that has been loosened by the acid.

Especially hard to clean are shells more or less disfigured by an unsightly mass of barnacles. Often, the mass may be detached in its entirety by applying pressure at just the right point with the cleaning tool, but all too frequently this is not the case and an unsightly white blotch is the result. This may usually be removed by carefully scratching the remains of the barnacle with the tip of a sharp pointed knife and reducing the remains of the barnacle to a powder; care being taken not to injure the shell.

Shells that are covered by a mass of vegetation of spongy growth may be readily cleaned by immersion in any of the chlorine solutions found at

most grocery stores. No fear for the integrity of the shell should be entertained, the chlorine will not attack the lime of the shell, but the specimen should not be allowed to remain in the solution for too long a time, as some loss of color through bleaching may occur.

Shells that are more or less rare are often found washed up on the beaches and are dull and very dead looking. Until they can be replaced by living examples, the color may be greatly intensified by a mild application of some greasy substance such as vaseline or other mineral fat. Application of some of the liquid wax preparations will often brighten up a dull and faded specimen.

To preserve the periostracum of such shells as *Sinum* and *Hydatina* which have a tendency to peel when very dry, an occasional application of wax or vaseline will prove efficient.

It is very important to remember that the collector is not creating a shell but is simply, in a manner "lifting its face" and we often see specimens that have been killed by kindness; they are over-cleaned and practically worthless. The method of dipping in hot acid followed by a plunge in ice water so as to create a false luster is to be avoided like the plague and is worse than trying to gild the lily. The same may be said of the use of varnish or shellac.

When a person takes the infinite pains and time to prepare his specimens properly, he can truthfully say that the collection is "a thing of beauty and a joy forever."

SHORT NOTES ON CLEANING SHELLS

Tools. "A discarded set of dentist's tools is unsurpassed for cleaning all types of mollusks . . ."—Clifford J. Awald

Cleaning Cowries. Cleaning cowries seems to be quite a chore, according to some collectors, whereas it can be fairly easy and not a lengthy process. Arguments for and against boiling were presented at an annual "Cleaning Shells" night of the Hawaiian Malacological Society. It boils down to this: There is no harm in boiling if the shell is put into cold water which is then brought to the boiling point. But a cowry plunged into boiling water almost invariably will come out with a checked surface as the enamel is cracked into a checkered pattern of a thousand intersecting fine lines. Those who advocate boiling say it toughens the flesh so that it may be more readily pulled from the shell.

Advocates of the "no boiling" method say that it just makes extra work. In the first place, the animal is attached to the shell in only one small spot, directly under the spire. The spire is hard to locate in older specimens as it is covered by succeeding layers of enamel, but in young or juvenile specimens it is very noticeable. Bearing this in mind, in specimens large enough to warrant it, cut the animal in two by drawing a razor blade from end to end of the aperture. One half can be pulled out readily, then to get out the half which is fastened to the shell, take a sizeable piece

of wire, 9 or 10 gauge, and file or flatten one end until it resembles a screw driver. Bend this end to fit the shell, insert and scrape the inside under the spire. Then hook out the remaining half of the animal.

If time is no object, bury your shell in a bucket of sand, with one end of the aperture down so that the decaying animal matter will drain out of the shell. This is important, because if allowed to stand in the shell the liquid formed by the rotting flesh will take the color out of any part of the shell in which it is allowed to stand. We have seen many a shell spoiled in cleaning this way; just recently a lady put a shell out into the back yard to let the ants clean it. The smell became too great, so she put it in a glass of water and left it for a day or two. When she took it out, it was so discolored as to be worthless, since the decaying animal matter in the water had taken out all of the natural color. So if you decide to keep your shell in water while the deteriorating process is going on, change the water and wash out the shell several times each day.—Hawaiian Shell News.

Hydraulic Cleaning of Shells. It would be hard to overemphasize the importance of water pressure in cleaning shells. One method is to turn the nozzle of a hose until it makes a jet, another to use the spigots in the laundry tubs, holding the shell to be cleaned in the palm of the hand and directing the water into the aperture.

If you are mechanically inclined or have a friend who is, try this: start with standard garden hose and get a reducer for the end at any plumbing shop. Take this to the carburetor parts section of an automotive supply store and get a brass reducer to fit on the first reducer; this may have to be soldered on. Keep adding reducers until you get down to the size of the base of an oil-can spout. Solder this on. This will reduce the size of the stream of water to a piercing jet the size of a pencil lead, and so powerful that if turned on full strength and directed against the palm of the hand it will give a burning sensation. Two minutes' use in the aperture of a boiled or spoiled shell will clean it completely. — Hawaiian Shell News, adapted.

Polishing Abalone Shells. Cover inside nacre and completely plug holes with a thick layer of melted paraffin. Put into a 50 percent solution of hydrochloric acid for a few hours. (Caution!). Polish with Crocus cloth, finish with powdered pumice.—Scripps Institution of Oceanography

Cleaning Shells when Time is a Factor. If possible, boil cones and other shells of the heavy and impervious type, immediately removing the dead animal with a wire. If any residue remains, place shell in methylated spirits in a jar (never use metal container) for 24 hours or longer, according to size. All tiny shells go into this solution for 24 hours; *Cypraea* and delicate shells for 12 hours. Hook out the animal and dry thoroughly; never use water. Another method is to put a layer of salt in a jar, a layer of shells, layer of salt, etc. With this method use a bakelite (or plastic) cover; shells can be so safely stored for an indefinite time, cleaned when the opportunity presents itself.—Mrs. E. B. Grigg, of Cairns, Australia, in *Hawaiian Shell News,* Vol V, No. 8

Removing Animals from Shells. This is one of the bottlenecks of conchology, especially in dealing with small or delicate shells which are easily broken in handling. The writer has recently come across an idea which might be helpful, and it is offered for what it is worth.

In dealing with Halocaridae, a group of small, mite-like creatures inhabiting the sea, Dr. Newell of the University of Hawaii "digested" the organic matter by using trypsin which is one of the ferments utilized in the body of man for liquefying food materials in the digestive tract. The technique used is a bit tricky, but with a little patience it might be imitated. He made an artificial pancreatic juice by dissolving 0.2 gram of trypsin powder in 10.0 CC. of 0.5 percent sodium carbonate. This solution is set aside for several hours but must be protected from disturbance by being kept in a larger vessel containing absorbent cotton or blotting paper soaked in toluene. The solution should then be filtered several times, using the same filter paper. The small animals were placed in the solution for periods of from one to three days at a temperature of 40° C. When the body contents have been adequately digested the specimens are washed in tap water. If protected by an atmosphere of toluene this solution will keep for a month.—PROF. TREVOR KINCAID, *Min. Conch. Club of S. Calif.*

Sawing Shells. It is sometimes desirable to saw into or halve a shell to show the internal structure. If the shell is completely filled with paraffin it may be sawed without fear of breakage, and the wax may be melted out in hot water.

Epsom Salts for Cleaning Cones. Make a solution of one teaspoon Epsom salts to one pint of sea water, enough to cover the shells. Soak for 2 or 3 hours, which will cause the animals to come out of the shells, frequently to more than a normal degree. The salts cause them to swell so that they cannot get back into the shell, and now boiling will toughen the flesh so that the entire animal may be easily removed by a wire hook or fine-nosed pliers. This technique works only for cones or other shells with a narrow aperture.—R. W. HAGEMEYER, *Hawaiian Shell News*

Oysters open of their own accord when placed in carbonated water. Sever the adductor muscle and you have them! Maybe other bivalves also respond to this treatment?

To Clean Bittium and other small, mud-encrusted shells, place shells in a jar or tube, add large quantities of table salt, enough so that the solution will be supersaturated when the jar is half-filled with water. Shaking vigorously will cause the undissolved salt crystals to cut the dirt from the shells, leaving them in the pink of condition without damage. Wash them in repeated changes of water. I have been employing this method for over half a century.—DR. PAUL BARTSCH, *Min. Conch. Club S. Calif.*

Commercial Cleaning. Commercial collectors use caustic potash to clean their shells; I have seen barrels of shells in such a solution which cleans them completely in a few hours. I would not suggest this treatment for a fine *Cypraea*, but *Cerithium*, *Turritella*, and like species are almost impossible to clean otherwise. The household product *Dra-no* works as well as commercial potash.—JOHN Q. BURCH, *Min. Conch. Club S. Calif.*

Shipping Shells without an Odor. On a collecting trip to the South Pacific and the Indian Ocean, Mrs. Mary Eleanor King obtained a formula from a chemist in Australia which worked marvelously in shipping shells; it is a white powder and the formula as given to her is 7-0-0 Cresantol No. 3. After preliminary cleaning, the shells were wrapped and the powder sprinkled liberally through the package on the wrappers (not the shells). The shipments came through without an odor.—HAWAIIAN SHELL NEWS, Vol V, No. 8

DREDGING FOR EVERYONE

By TOM BURCH

Reprinted from 1941 Annual Report, American Malacological Union

I suspect that almost every shell collector who has gotten up at an unearthly hour in the morning to collect at a minus tide has gazed out beyond the narrow bend of shore left uncovered by the retreating waters and wondered what rare treasures he could find if the sea would but drop a few hundred feet or so for a while. Or what shell collector, strolling along the beach after a storm, hasn't wished that he could go out beneath the waves and collect live, perfect specimens of some of the shells that lie broken and worn at his feet? The vast majority just sigh and decide that the "deep stuff" can only be collected with complicated and expensive equipment and is only for institutions and individuals with plenty of money. A few consider it further and decide that while it would be much easier and more pleasant to dredge from a two-hundred foot cruiser with power winches and a crew to do all the work, if one has a strong back and a few dollars he too, can get some of this material.

Whereupon the ambitious collector makes a triangular or rectangular iron frame with a row of holes along one side, or gets a blacksmith to make one for about fifty cents, and gives a friendly fisherman fifty cents for some old fine-meshed fish net. On the way home to sew the net onto the frame, he stops at a hardware store and buys about 200 feet of 3/8 inch manila rope for two or three dollars. Then, taking this simple equipment and some containers for the catch, he goes to the beach, rents a skiff for a few hours, rows merrily away from piers and boats, and begins to dredge. A few hours later, depending on the physical condition of the dredger, the ambitious collector returns wearily to shore, a tired but happy person who, in a couple of hours, has collected more different kinds of shells that are new to his collection than he had dared to hope.

I must hasten to say that it does not always turn out as nicely as that. The spot chosen for dredging makes a great deal of difference. Some who would have become ardent dredging fans have given it up as a bad job after they tried to dredge in a shallow mud slough and got nothing but barren gooey mud, or after they tried to dredge among large rocks and got nothing and perhaps lost their gear. If the embryo dredger is persistent, however, and not easily discouraged, he will continue, profit from his mis-

takes, and in time become quite adept at this mode of collecting. Incidentally, if he does continue to dredge, he will soon have many species of shells that less fortunate collectors can never get except by trading, buying, or going dredging themselves.

Boats. While it is sometimes possible to get some very good material by just throwing a dredge off from the end of a pier and dragging it in, a boat of some sort is really essential. I have already suggested that a person with a strong back can dredge a lot of fine material with a skiff. My readers will probably not believe it until they have the experience, but a man can drag just as large a dredge and fill it just as full by rowing as one can with an ordinary small motor boat. Needless to say, the rower will not be able to make as many hauls as the motor boat operator.

In choosing a dredging boat, the most important item to consider, in my estimation, is seaworthiness. If one is going to dredge in the open sea with a small boat, he must always remember that the wind and the sea are treacherous, and if his boat swamps he is in a mighty precarious position. Incidentally, in such a case the safest thing to do is to stay with the boat, unless it sinks. If you are going to dredge with a skiff or flat bottomed rowboat, be sure to get one that was made for the ocean and not for some quiet lake or lagoon. It should have a fairly wide beam so that you can stand up, if need be, without tipping it over, the sides and stern should flare a little and there should be some shear. If you have never rowed a boat, learn how to do that first. Have some old "salt" show you or read how to, in a book. Also, do not try to dredge everything the first day, leave some for other times or your hands will look worse than hamburger, even if you wear gloves—which good oarsmen never do.

The next step above rowing a skiff is to power a skiff with an outboard motor while dredging. Choosing the outboard motor presents quite a task, especially if you have to keep your hobby within a narrow budget. I can tell you from experience, however, that it is better to pay a little more and get a good dependable (as outboard motors go) motor and then take good care of it. I shall never forget the hours that I have spent trying to start, taking apart, and then putting back together again the cheap little outboard motor with which we started, nor shall I forget the miles that I rowed when I did not get it started.

It is rather important to match the motor and the boat; if the motor is too small for the boat, you will have to help it out with the oars, while if it is too big, it is likely to push the stern under the water when the power is turned on.

After trying out many different kinds of boats, I believe that the one that we have used for the past three years is the best for ordinary dredging, within its price field. It is an 18-foot New England dory with a "well" for an outboard motor and a shive or pulley in the stern. The "well" is so arranged that one person can sit behind it and tend the dredge. Forward of the motor operator's seat is a hand windlass on which the line is wound. We had the hull built for $100 and the motor which I am now using is a 10 horse power Johnson outboard which sold new for $180. Let me say

right here that the only advantage of a 10 h.p. motor over a 5 h.p. motor is that you can go faster from one place to another and thus extend your field of operations, but you cannot get any more in your dredge, or if you do, it is apt to stay on the bottom.

Even though there is never enough room on a small dredge boat, I would recommend that your boat be equipped to sail. I would also advise that you learn to sail it before your motor fails during a heavy sea, and you have to. The narrow stern is about the only drawback to a dory as a dredging boat. However, its redeeming features of seaworthiness and adaptability more than make up for the cramped quarters.

One very great advantage of a dory using an outboard motor over a boat using an inboard motor, is that you can always take the motor out, land through the surf, put the boat on a trailer, take it somewhere else, launch it through the surf, and dredge there.

There is no doubt about it, power boats with inboard motors are by far the nicer to dredge with, especially if they have a power winch to pull up the dredge. However, here even more than with rowboats, be sure to get a seaworthy craft, as you are likely to wander miles from shore and possible aid.

If the boat is large enough it is advisable to rig some type of derrick or frame on the stern to facilitate getting the dredge aboard.

Dredge Line. The simplest type of dredge line is rope. Some prefer to use ½ or ⅝ inch manila rope as it is large and easy on the hands. This is very good if one is dredging on a shallow, rocky, or shale bottom and does not get it permanently fastened to the bottom. This heavy rope, however, is too bulky for anything but very shallow dredging (5 to 20 fathoms) and is also much more expensive than the smaller rope which is just as good and sufficiently strong. My father and I have dredged in as deep as 50 fathoms with ¼ inch rope by fastening small weights to the rope at several places. These weights are necessary in deep dredging with rope as it has a tendency to float and pull the dredge off the bottom.

To dredge in more than 20 fathoms with rope, it is necessary to devise some sort of windlass on which to wind the rope. If you do not use a windlass, it always seemed to me that the rope becomes more tangled when an attempt is made to coil it when dragging in the dredge than if simply allowed to fall naturally. If you buy a full coil of rope as it comes from the manufacturer, be sure to ask the dealer the correct way to open it and take out the rope, as it will be full of kinks, one for each coil of rope, if not done correctly. Incidentally, if this should happen, pull in the rope, stick the end up through the hole in the center of the coil and pay it out from there. This will remove all of the kinks and the rest of the rope will not be kinked.

If you are going to dredge very deep (50 fathoms or more), it is much more convenient to use cable, as rope has a tendency to float and pull the front end of the dredge up. The chief objection to cable is the cost. A thousand feet of good cable probably would cost about $100. We have

gotten around this difficulty very nicely by using twisted wire clothesline which costs about $10 for a thousand feet. This "cable" is good for only one season, or if a great deal of dredging is done, only a part of a season. There are two types of this twisted wire clothesline, one of which has a string down the middle, also called cash line. This is much more flexible than the other, but will not last as long. It is best to keep the cable oiled with heavy oil or grease.

Needless to say, a windlass or winch is necessary if cable is used. If your boat is large enough, connect the winch to the motor. If not, crank it by hand.

Types of Dredges. Dredges can either be very elaborate or very simple. It is possible to make a dredge that will work, from a five gallon oil can or a piece of iron sewer pipe. These are not as practical as others but can be used in a pinch. Every person who has done very much dredging has his own ideas as to the best type of dredge. Probably the most universally used type consists of a rectangular iron frame with flanging (not very much) cutting edges and iron bridles which are tied together. A fine-meshed fishing net is sewn to the iron frame and a heavy canvas sheath over the net. The end of the net is tied shut instead of sewed, so that the material can be removed from the back.

We have had better luck, however, with a triangular dredge and metal net. These are made with two triangular iron frames connected with iron bars at the apices and a copper screen for a net protected with $\frac{1}{4}$ inch hardware cloth. The advantage of this dredge is that the maximum cutting edge is always on the bottom and when it is brought up, the material can be screened before removing it from the dredge instead of after it has been hauled into the boat and dumped.

Probably the most efficient cheap dredge consists of a triangular, circular, or rectangular frame with fish net or hardware cloth for a bag. A dredge such as this can be made for less than a dollar.

While the dredge can be considered the standard implement for obtaining marine life from the bottom of the ocean, various other gear, such as trawls and tangles, can be used with success. While there are many different types of trawls, I will only describe a simple beam type that I have used with good results. It consists, briefly, of two iron runners connected to a wooden beam. The size depends on the power of the boat that is used to pull it. A long net is fastened to the beam and the rear end of the runners. The amount of sag to the lead line which drags on the bottom is very important. If it is too little, it digs too much, while if it is too much, it rolls over the material. The right amount must be determined with experience. In addition to a few lead sinkers along the lead line a heavier weight at each end of the line on the runners will help the net for protection and the end tied shut and not sewed to facilitate removal of the haul.

The trawl is used on a sand or mud bottom and is used to cover large areas. It only picks up the larger shells, etc., and lets all the little things go through or under.

Tangles are especially useful on rocky bottoms where it is impossible to use a dredge or a trawl. They may be used, however, on any type of bottom. Tangles consist of a beam with a few short pieces of chain to which is fastened unravelled rope.

Dredging Operations. Probably no two persons who have dredged very much agree on just what equipment is best and how it should be used. My father and I have dredged together quite extensively for the past six years and *we* do not agree on the proper procedure, so no one else will probably agree entirely with me or anyone else.

The principle of dredging is very simple: you merely throw the dredge overboard, let out about three times as much line as depth, drag it until it is full, pull it up and remove the contents. The only way to learn to dredge is to *actually* go *out and dredge.* You will soon be able to tell by the feel of the line if the dredge is on the bottom and digging; in fact, you will soon even be able to tell what type of bottom it is by the way it jerks. Mud hauls usually just get heavier and heavier, sand hauls have many little jerks depending on the character of the sand, while gravel hauls are decidedly jerky and very uneven. The deeper the water, however, the more difficult it is to tell anything about what is happening below.

It is very important when dredging with cable to keep the line taut by moving the boat forward from the moment the dredge is thrown overboard, otherwise the cable will get full of kinks and break easily. This is not so important when using rope, if one is careful to keep the rope clear of the propeller, but it is usually a good idea.

A weight of some sort should be placed between the line and the dredge to insure that the cutting edge stays on the bottom. A three or four foot piece of heavy log chain is the most convenient kind of weight, but a sash weight, or anything else will do.

It is impossible to dredge except at very slow speeds; otherwise the dredge is likely to be pulled clear of the bottom. It is much easier to keep the dredge on the bottom when dredging uphill than down; in fact, if the slope is very marked, it is almost impossible to dredge downhill. The more line you have out the easier it is to keep the dredge on the bottom.

On dredges with iron bridles it is a good idea to make the dredge line fast to one bridle and tie the other to it with a cord. Thus, if the dredge gets caught, the cord will break and the dredge will pull free. As an additional safeguard against breaking the dredge line, it is best to have some arrangement so that the line can slip out of the boat if the dredge gets caught. This is more important with a larger boat.

If you ever try to dredge on a shallow shale bottom and have difficulty getting anything because you get "hung up" on projecting pieces, try this trick, used successfully at Monterey, California. Use heavy rope, $5/8$ inch, and when the dredge gets stuck so that you cannot pull it off, open up the motor, slow down, take in about 10 feet of slack, and then speed up again. If it doesn't break off the piece of shale that the dredge is caught on or

tear the dredge to pieces after three or four tries, you had better pull it up, if you can. Back up and pull from the other direction, if you have difficulty getting it off the bottom. Occasionally it is impossible to get it loose, but in the end it is worth the trouble and expense.

Taking Care of the Hauls. When a dredge load is brought up, it should be screened. If the dredge is made of screen, this can be done before bringing it aboard. Otherwise the load must be dumped and screened with small screens. If this is not convenient, just empty the dredge into a sack and take it home to screen. Gravel and rocks should be taken home and washed through screens of varying meshes to separate the material according to size and thus make sorting easier.

The bottom off the West Coast is spotted with small patches of very good bottom surrounded by large areas of poor bottom with relatively few shells in it. For this reason, it is very important to keep track of the good hauls and the poor hauls. To do this it is probably best to keep each haul separate until it is dried and sorted. If several hauls are from about the same spot and are apparently the same material, there is no need to keep them separate. After the material is dried and sorted, what to do with it is up to the individual.

We place everything from the same locality, approximate depth, and character of bottom together. Thus the material that we have dredged off Redondo Beach, California, is divided into 10, 25, 50, 100, or 150 fathoms; mud, sand, gravel or rocks, depending on which it is closest to. Each collector will have to make up his mind according to how much time he has for bookkeeping.

Unless you are not interested in the semi-microscopic shells, do not throw any of the material away until after it is dried and re-sorted, as it is practically impossible to see while the material is wet. We usually screen the material, sort out what we can see readily, dry it and then re-sort it at our leisure. This latter sorting can even wait until winter if you are pressed for time.

I have suggested that it is a good idea to keep track of the good dredge hauls and the poor, so that you can later return and dredge more of the good material. However, finding the same place again is quite a problem. Trying to find a good dredging spot that you hit by accident is like being the blind man in "blind man's buff." When you get a good dredge haul be sure to take all possible bearings on objects on shore. Try to get two objects on a line from two or three different directions, take a few compass bearings on points, etc. and any other bearings possible. The next time you are out maybe you can get within a quarter of a mile of the spot you are looking for.

If you use iron cable for dredge line and use a small boat, you cannot trust a compass for bearings. They are bad enough for close work on any small boat without having a lot of changing iron in the boat. Probably the best way to determine your location is to use a sextant and a three-arm

protractor. To "fix" your position with a sextant take two angles between any three objects or points on your chart, set the arms of the protractor at these angles and place it on the chart with one arm passing through each object. The center of the protractor indicates your position. A cheap sextant will work satisfactorily for this purpose. The one that I use cost $4.50 and the three-arm protractor costs $6.50.

FOUR TO FOUR HUNDRED FEET BENEATH THE SEA DREDGING IN FLORIDA WATERS

By Jeanne S. Schwengel

Reprinted from 1941 annual report, American Malacological Union

Collecting mollusks is one of the most fascinating time-takers in the world, and for the amateur it opens up a new world of creatures strange and rare. For those of you who have never dredged, let me say that once tried, the urge to continue is irresistible. There are those few moments of suspense, as the men begin to haul in the dredge, when you wonder, with a consuming curiosity, just what they will dump before your eyes, maybe only broken shells and rubbish (garbage, we call it), but mostly you will find treasure upon treasure. The very shell you had so hoped to find, but never really expected; another of this and of that, so that you may share with other collectors; one load after another, never the same, always interesting.

To go about this work the weather must be propitious. Dredging simply cannot be done in a satisfactory manner if the sea is too rough, or the day too cold or wet. My first dredging was under the experienced tutelage of Mrs. Nelson R. Perry and Theodore T. Dranga, and I doubt if two more capable or experienced teachers could be found. Our boat was one of the fishing cruisers of Sanibel, large enough to be comfortable for us all, and powerful enough to haul our heavy dredges at any depth we wished to fathom. The dredges we had made at a blacksmith shop: a strong iron frame about 36 x 20 x 8 inches, covered with heavy ½ inch wire mesh, a heavy flanged cutting edge on both 20-inch lips, iron rod arms from each corner of the opening, each two side arms converging into a loop for a 6-foot chain which joins in another ring, large enough for the ½-inch, or more satisfactory ⅞-inch manila dredge-line to be run through and safely knotted. At times we use a regulation Maine scallop dredge, and again a tangle, which is made of a cross-bar to which our dredging rope may be attached, and a mass of unravelled manila rope of varying lengths, the whole about 30 inches wide and about 8 feet in length. This is an excellent way of collecting pectens of all species, and in many cases *Spondylus* will be dragged up with the tangle, also *Pinna* and other shells with a rough surface that will cling to the threads of the tangle.

For dumping of the material, we have had built what we call a dredging-board. It is about 3 feet wide and is arched slightly in the center so that the water will run off easily. It reaches about a foot beyond each

side of the boat, and has a rail about 3 inches high on each side, with the ends left open. This is placed across the back of the boat, leaving space for the men to stand between it and the end of the boat, unless there is a small deck, as in some fishing boats, in which case the board is placed as close to the deck as possible, and then the men stand on the deck to do their hauling.

When dredging in waters which are not familiar, it is best to have one of the Government Geodetic Maps, which gives depths and the type of bottom. By consulting the map you can determine what type of shells you are apt to bring up, how much rope to use, and which type of dredge will be most satisfactory. Another necessity is a sounding lead to check your depths.

One of the men always sits with his hand on the dredge line and, with practice, he can tell just what type of bottom the dredge is working on; if it is biting, or floating. In great depths, weights must be attached to the dredge line near the mouth of the dredge to keep it on the bottom.

Along the near side of the dredge board, we have tacked heavy tape, making pockets for different sizes of bottles, which are fitted into place as soon as the dredge goes overboard. These are partially filled with water, so that the shells will have a cushion when they are dropped into the containers. It is well to have several different sizes, and the shells can be more or less sorted as they are collected. Under the board are placed large buckets into which are put the larger shells, pieces of coral, and in some cases, old shells or algae. These things are looked over carefully after the small shells are cleaned, and many minute shells are taken in this way. All records of depth, location, and type of bottom should be kept with each dredge load.

When the dredger feels that the dredge is full, and this knowledge comes with practice, the word is given, and the boat slowly backed as the rope is hauled in, so as to take up slack, and when the rope is vertical, the dredge is hauled up and the contents dumped on the dredge board. The sponges, beautiful colors and rare shapes, but vile smelling, are quickly looked over, and in most cases dumped overboard before we really begin the work of sorting the catch. Rubber gloves should always be worn, as the sponges and algae are sometimes poisonous, and will cause an annoying rash. Quite often small morays, crabs, and the vicious dog fish are brought up, and the hands must be protected. It is very helpful to use strong forceps, about 12 inches long. They can be used to pick up near treasures, reach over for those at a distance, stir up the mess when the top layer is sorted, and are fine to push the discard off the ends of the dredge board when one is reasonably sure there is nothing of value left. In fact, forceps or tweezers are almost a necessity, as the hands are very clumsy in rubber gloves.

A jar of preserving alcohol is often useful, either for a fine shell whose animal must be retained, or for those too small to be cleaned, as *Melanella, Bittium, Cerithiopsis, Caecum,* etc. Also, whenever dredging, I throw in all

small fish and crustaceans, and have collected quite a number of new and very rare specimens of each, which are gladly received by the Museum.

Last, but certainly not the least important, is a jug of fresh water and a substantial lunch. If there are cooking facilities on the boat, have something hot, as food is a great cure for sea-sickness, and nothing upsets the equilibrium as much as dredging. The motion of the boat, the exhaust odors when the boat is backed to facilitate hauling of the dredge, the movement of the mass on the dredge board when working it over, and the noxious odors of the assortment of sea life so close to your nose, is all very annoying.

But, no matter what the inconveniences of *mal de mer* or aching back, the catch is always well worth the struggle. So join the crowd for more and better dredging.

DREDGING ALONG THE CALIFORNIA COAST

By John Q. Burch

From Minutes of the Conchological Club of Southern California, No. 82, August, 1948

Our experience has been to find that the bottom at depths of over 200 fathoms is composed of ooze with very rare exceptions. The use of a regulation dredge on such a bottom is always very disappointing because it fills at once and contains a small percentage of life. We found that our most successful gear for deep use was a small beam trawl about 6 feet wide at the mouth and running a net back from it perhaps 18 feet in length with the last 6 feet tapering to a cylindrical net of $\frac{1}{4}$ inch mesh or smaller. This would fill also even though we had nothing to drag the bottom but the leaded line at the bottom of the net.

Instead of trying to bring up the entire rig, however, especially when we had it down at times as deep as 3000 feet, we would simply drag it off the bottom and run with it a short distance. In this fashion the ooze was washed out and a certain percentage of the living forms dropped down into the smaller mesh at the bottom. Then we would lower it again and not haul up until we had made as many as 8 or 10 drags on the bottom.

Of course, using the light tackle we would almost necessarily lose the entire trawl occasionally. Bearing this in mind we never tried to make our gear expensive or fancy. We found that by having our local blacksmith make up a dozen at a time we could buy them at reasonable cost and when we lost one we simply went up forward and got another to put out without having to grieve over the loss of one trawl.

The loss of a trawl was often caused by the fact that we would occasionally run into a large number of something such as holothurians or even deep water sea urchins. Obviously, if you fill such a huge net as you have on a trawl with anything at all that must come to the surface as is, the chances are that you will never get it up. And of course, odd things did happen. I recall the time we just barely made it to the surface with a

haul that was heavy to the point of snapping. We fondly expected a haul of hauls, but found that we had picked up a small ship's anchor.

One interesting thing about the bottom is that there seem to be definite colonies of rich material, and these colonies or spots have always been a puzzle to us. For example, we had one spot off Rocky Point in about 85 fathoms; this was not really deep but contained a fauna that was almost unbelievably rich. I will not try to list any of the species here but suffice it to say that when we did hit this spot we invariably had a haul of many of the rarest as well as some of the most beautiful shells from this coast. But this spot was so small that we would drift off it in the time it took to bring up the dredge. We carried our charts and sextant and took the most careful shots time after time. One would think that by using a sextant with at least 3 shots we could get back in position without difficulty. However, our batting average at best was never as high as one out of five hauls. It should be explained that the bottom on all sides of this spot was composed of ooze and that the spot was certainly no larger than perhaps 100 yards in diameter.

I am inclined to think that in order to do deep water work effectively it is necessary to work in the same locality long enough to get to know the bottom. We had all of the charts we could buy but finally almost made our own.

In the way of tackle we worked for years trying to perfect something that would work well on bottom composed of pinnacles of rock. Very little work has ever been done on such bottom for the simple reason that it is almost suicide for the dredge to get into them, and a trawl is out of the question since it would be torn to pieces almost instantly. The best thing we ever worked out for use here was a circular piece of steel more or less of the bands on a small wine barrel, probably 18 inches in diameter. To this we attached 3 lines for the bridle, leaving long lines to the bit, and on the steel circle we attached a short net well protected with heavy canvas, of course leaving the end of the canvas open. The incentive of so much work was that these rocky pinnacles were covered with brachiopods and some species of rock shells that simply were not to be had in any other way.

It might be mentioned that right here on these pinnacles we did at times use a tangle with some success. A tangle is not to be recommended as a piece of gear with which to collect shells ordinarily but here we would find that we were bringing up quite a lot of several of the rare deep-water Boreotrophons that were not taken in our open dredging. Of course, the students of echinoderms would have been delighted because the tangle would come up loaded with really beautiful living crinoids and other rarities in this group. In fact, deep-water sea urchins in great demand by students of this group are a first-class nuisance to shell collectors because the tangle will get loaded down with these things and it would take hours to pick them all out of it. For our tangle we used a piece of steel pipe and attached to it all along unravelled manila rope, running back about 20 feet.

We had one rather large spot on the north side of the Redondo submarine canyon that we always found interesting and productive. We called it simply the Foram spot, because the Foraminifera were so very abundant that after washing we were literally picking our mollusks from a mass of Foraminifera. For some reason this locality was especially good for collecting some rare genera of the Turridae. As a matter of fact, there were a number of things from here that we couldn't name and sent on to Dr. Bartsch who was working on the group.

We were fortunate in having the deep submarine canyon running off Redondo Beach. One of the easiest ways to be sure of getting a good haul was to check the chart and run off the edge of the canyon into possibly 300 fathoms of water, drop the dredge down as deep as we wished but short of the bottom, then simply start the boat and run for the bank which would probably not be over 50 fathoms. In dragging the dredge up the side of the canyon we invariably got a fine haul BUT with one very serious drawback. We tried to keep very accurate bathymetric ranges on all of our material; obviously in any such maneuver as this we would have no idea whether we picked up a certain shell at 100 or 50 fathoms.

Some of the toughest dredging I ever tackled was on a shale bed off Monterey, California. The bottom here, running from the beach off Del Monte down to around 40 fathoms, is shale and rock. The result is that a dredge is hardly down before it is caught. To attempt to free it by running back and forth over it or anything else is simply an exasperation. We found that the only thing to do to collect in real quantity was to tear up strips of the shale bottom and bring it up, rocks and all. I recall one of our first trips up there; we were met by 3 local shell enthusiasts and they all had dredges of their own—10 in all—each the result of the fond and motherly care of the owner and representing every type known to dredgers. We took along 7 dredges of our own. We worked there 3 days, and at the end of that time the only remaining dredge had the heavy hardware cloth sides simply cut to ribbons. We also had over 300 fine living *Pterynotus carpenteri*, several *Hemitoma bella*, and countless Ocenebras, Calliostomas, and many other things that kept us busy for weeks afterwards. We averaged about 400 pounds of good dredgings which is not bad in any dredgers' club.

The difficulty of getting some of the things we always wanted badly is still a puzzle to us. For example, off Redondo Beach we would bring in hauls composed of hundreds of recently dead valves of our quite rare *Pecten diegensis*, adult shells averaging 4 to 5 inches. In with these we would bring up quite commonly smaller living specimens averaging the size of a dollar; rarely indeed did we get a living big one. We concluded that this mollusk is simply active enough to swim out of the way of the dredge.

At certain seasons of the year we had another problem to contend with in the heavy growth of marine algae. Our favorite spot for dredging always with success was what we called the gravel bed. This ran from about 25 fathoms on out to possibly 40 fathoms, and the bottom was simply

ideal in that it was composed of stones, few larger than a man's fist. It was a simple matter to bring up a dredge full of these rocks and in them was a rich fauna of shells, deep water chitons, interesting in every way. We took several new species from this locality. But at times the algae would get so heavy over this gravel that an ordinary piece of our gear would simply slide along over and through the heavy algae (composed largely of *Acrosorium*) and never get to the gravel. We found that a dredge with a circular opening and plenty of weight in front of it would cut on through and get some of the stones for us.

Incidentally, that last sentence is probably the most important in this whole rambling article; more dredgers have failed because of their reluctance to hang a really heavy log chain on the front of the dredge bridle than for any other reason. It is impossible to dredge unless you get the dredge on the bottom and keep it there.

Of course, cable is the thing to use in any kind of deep water work, but some very fine things can be brought up by the use of a small boat and rope line, with the limitation that when you are working in more than 50 fathoms you have almost a boat full of rope. The drum on the winch I now have contains 7,200 feet of good wire cable. It takes up no more room than one spool of ½ inch manila rope. Another tip may be in order: rope is almost unbelievably buoyant, and to get it down is your problem. We used to take along a box of small window weights, about 4 or 5 inches long, and fasten one of these to the rope about every 50 feet after getting it started down. And we *always* used a good piece of heavy chain just ahead of the dredge bridle.

There are still so many things to know about dredging. One is the things you know are there but can't get. Dead valves of our very rare *Anatina* for example are not uncommon, and while we have brought up many broken valves (it is very fragile) we never brought up a living shell. No dredge we ever used could cut deeper than a few inches, so those things just must live too deep for us. The extremely delicate things were always an annoyance; *Solemya* is an example. We dredged thousands of these and I think we managed to get 2 or 3 decent living adult specimens. Other fine things that we dredged with an average of 99 percent smashed in the dredge are *Cyathodonta undulata* and *Periploma discus*. Toil and trouble and rewarding enjoyment — that's dredging.

DIVING FOR SHELLS

By Thomas L. McGinty

Reprinted from 1941 annual report, American Malacological Union

Doubtless, the art of diving was known to man long before he became civilized. The first divers probably knew nothing of pearls and treasure but contented themselves with tapping nature's lavish supply of food in the shoal waters close to shore. Although primitive, according to modern

standards, this simple method known as skin-diving is still employed by native pearl divers. It is equally as well adapted to the collecting of shells.

For the sake of better vision, the diver-collector had best be equipped with some kind of underwater goggles. The most useful type, more of a mask than a goggle, is made of a single sheet of glass fitted into a rubber cup which fastens over the diver's face, leaving his mouth exposed for gasping air at the surface.

The collector need not be a masterful swimmer, capable of holding his breath for long periods under water, for many interesting shells are to be found at wading depth and by the simple expedient of placing his face in the water he may examine the rocky crevices and closely observe the gorgonians for possible molluscan life. Heavy rocks, too large to be turned over without the water's helpful buoyancy, may be flipped over and the under surfaces carefully searched for living specimens. It is a fascinating and profitable experience which affords the collector a view of undersea life quite unattainable through a glass-bottomed bucket, from the surface. The limiting factors are, of course, the inability to stay down as long as desired and the relatively shallow depth to which it is practical to descend. At 30 feet the pressure upon normal ears becomes extremely painful and it is dangerous to attempt diving much deeper.

Wearing heavy canvas gloves is advisable if rock turning is planned. Caution must be exercised before a hand is inserted into a crevice or rock cavity, for, in tropical waters, morays and stone-crabs are capable of inflicting serious injury. The modern bathing suit exposes such a quantity of human epidermis that care should be taken to prevent stinging hydroids and corals from touching uncovered surfaces. The stinging, although not particularly dangerous, is most annoying. Clear water is as essential to the diver's safety as it is to his efficiency. Large fish are much less likely to mistake a diver for something edible if the visibility is good. In the event that a barracuda should approach the swimmer must endeavor to be calm and deliberate in his movements. He should never attempt to work around rocks in a pounding surf, for the glass face-plate might be smashed with disastrous results to his eyes. Some sort of a "game bag" is almost necessary. It may be tied about the waist but must be so fashioned that it cannot dump its contents. If vials are used, they should first be filled with water, for air-filled vials have a disconcerting tendency to float away and become lost.

It is extremely difficult to offer any helpful suggestions regarding manner of collecting and where to look for specimens. Habits of marine mollusks vary widely with locality and often the best collecting occurs in the least likely habitat, hence, no regular rules may be followed. Much remains to be learned about the habits, breeding cycles, and seasonal migrations of even the commoner mollusks. No one knows why an area which affords marvelous collecting one year may be devoid of life the next. Remember, however, that most mollusks are exceedingly gregarious and while the search for that nearby colony may long seem futile, persistence, in the end, does not go unrewarded.

For general usefulness and practicability to the collector, nothing seems to surpass the skin-diving system. There is, however, another device, the diving-helmet, which offers certain advantages. Because of the helmet's constant supply of fresh air, pumped down from the surface, a diver is permitted to roam about leisurely and in comparative comfort at greater depths than is possible with goggles. For purposes of observation the helmet is almost ideal. The collector has ample opportunity to watch for the telltale movement as the large *Pecten* and *Spondylus,* ordinarily so covered with algae as to be unrecognizable, snap their valves closed. He may also gather large sacks of sponge and other material to be sent to the surface and later examined for living minutia. In fairness, we must admit certain disadvantages for this manner of collecting. The associated gear is necessarily bulky and expensive. On the bottom the diver finds movement clumsy and awkward, for the helmet must always be maintained in a nearly upright position to prevent the precious supply of air from escaping. Also, helmet diving is not entirely without an element of danger. Contrary to popular belief, few divers are lost because of attacks by undersea creatures; most are lost because of defects in diving mechanism which throws a sudden strain on the human system, a system never designed for such abuse.

We shall not attempt to discuss here the effects of pressure upon the human organism but suffice it to say that present-day man is poorly adapted to withstanding any considerable or sudden changes of air pressure. This same air pressure, so necessary to counteract the crushing weight of the water, is always the diver's greatest fear, for with it come the dreaded "bends." Fortunately, the shell collector is unlikely to be diving at a depth greater than 35 feet and may disregard the worries about decompression to prevent the occurrence of this crippling malady. Make no mistake, however, for the pressures encountered in helmet-diving at depths no more than 20 or 30 feet are potentially dangerous. It is important that a novice fully realize this fact and exercise every precaution to avoid trouble. Rule number one should be: *Never leave the helmet while it is under water.* The United States Naval school of diving considers a rise of only 7 feet to the surface, when the lungs are filled with air pressure, as being dangerous to human life. When you go down or come up from a dive, do so slowly and continue regular breathing at all times. Never hold the breath while ascending, even though the air in your helmet may seem foul. Rule number two should be: *Move slowly while under water.* Any unusual exertion brings undue fatigue and the diver must always have sufficient energy in reserve to cope with problems that cannot be anticipated. Observe these simple rules and you will be safer in a diving-helmet than you would be while crossing a busy city street.

Perhaps some AMU members have yet to make their first dive, and are curious to know something about what one sees and does below, before making the venture. Let us go on an imaginary diving trip together.

For our first dive let's explore the wreck of an old schooner which lies in 30 feet of water along the edge of a Florida coral reef. You are probably amazed at the various assortment of gear which is needed for the diving

operation. The bulky helmet weighs nearly 70 pounds and has a safety-valve where the air hose connects, so that even should the diver cut his hose, some air will remain trapped within the helmet. Enough, we hope, to keep him alive while he climbs back to the surface. Amidships is the air-pump, a manually operated 2-cylinder affair, which requires considerable dexterity upon the part of the pumper as he works the long handle from side to side, the constant heaving of the sea tending to throw him forever off balance. The long coils of air-hose are cumbersome and ever in the way until finally fed out to the diver.

With a glass-bottomed bucket we locate the wreck and drop anchor. Down goes the descending-line, a rope with heavy weight attached, dangling just clear of the bottom. You're the first down, so jump off the stern and hold the descending-line firmly while someone drops the helmet over your head. Raise your right arm and the tender will make a loop of hose around your shoulder so that if he desires to bring you up suddenly he won't haul in a helmet, but no diver. The helmet weighs a seeming ton at the surface so try to keep it balanced, for if you lean too far back its weight appears about to break your neck. Some one thrusts a hammer and crow-bar into your hand and you hastily secure both, in some fashion, under your belt. The pump tender is giving you air and signals you off so you begin the descent. Down you go, very slowly hand over hand, on the rope. How dead your ears suddenly feel! The only sound in the universe is that thumping of the valve in your helmet. Rhythmically it goes on, almost as if you were listening to your own heart beating. The helmet no longer feels heavy, now you are light and free and the slightest effort is sufficient to make you go up or down on the descending-line. At a depth of 20 feet you feel an increasing dull pain in your ears. Don't worry, but climb back a yard or so on the line and swallow a few times. You must force some of the air under pressure into the tubes leading to the inner ear so that the ear drum has an equal pressure on both sides. Ah, that feels better, pain's gone, so keep swallowing and drop down the rest of the way more slowly.

At last, like a figure in slow-motion, you feel your knees give slightly and alone you stand on the ocean's floor. For a moment you'll fondle the descending-line and hesitate to give up that last tangible connection with the world above, for as you gaze about, you realize that this is a different world, far stranger than anything you had ever dreamed. Myriads of living creatures, seemingly forever in effortless motion, lend an air of unreality to this strange fairyland. In the dim distance the great pink sea-fans sway slowly to and fro, for all the world like trees in a breeze, but a gentler, softer breeze than the earth above has ever known. The uncanny coloring is strange and vivid. Objects close by are weirdly tinted with a suffusion of pale green, those just beyond have a faint bluish aura enveloping them, while at a still greater distance the water seems to shroud everything with a heavy veil of deep indigo. The surface, far above, is an ever undulating mirror which reflects sparkling but inconsistent patches of light upon the clear sandy bottom.

After a few moments of choking sensation of almost unbearable solitude the sense of intrusion upon a world forbidden begins to pass and in its place comes a feeling of complacency. It is almost as if you weren't quite sure but that you really belonged here. Your courage mounts and an urge to explore sweeps over you, so, leaving the descending-line behind, you make your way towards the wreckage on the sandy bottom. Progress is not nearly so rapid as you had supposed it would be. The body seems light and feet have trouble getting proper traction, but by leaning far forward and bending the knees slightly, you move about with reasonable ease. A foggy mist has formed on the face-plate within your helmet, and since it obstructs your vision you clear things up by sending a mouthful of sea-water forcibly against the glass. Perhaps you hadn't realized before, how high the water in the helmet rises.

Before you lies a great vertical wall of wreckage so covered by algae, sponge, and coral that it bears not the slightest resemblance to any conceivable part of a ship. Peering intently through your little window your eyes pass over patches of deep purple, bright red, vivid yellow, orange, lavender, and green—colors so fantastic and irregular that they quite defy description.

Wait a moment, there was a sudden movement in that patch of heavy algae just in front of you, and a speckled brown something, visible a moment before, has quite disappeared. You become interested and examine the area more closely. Ah, yes, here it is: a large *Spondylus,* so covered with a coating of algae as to make it undetectable. But for that slight movement, as it snapped its valves together, and the sudden disappearance of its brownish mantle, you would surely have passed it by. You remove it with hammer and crow-bar quite easily but are careful not to injure its long flat spines, for this is a really superb specimen. The *Spondylus* is so large that it alone would half fill your game-bag so you decide to deposit it on a clear patch of sand, and pick it up later, when you return. Other movements in the thick algae attract your attention and you discover that they are caused by many large *Arca* and *Chama,* so perfectly concealed as to be otherwise impossible to find.

A little further along you pause in front of an unusually attractive patch of brain coral. Using the crow-bar you pry off chunks at the edges and search for coral dwelling mollusks, like *Coralliophila.* As you work, surprising numbers of small fish, the "slippery dicks," appear from nowhere to nibble at the "crumbs" you leave.

Wandering on, your eye catches flashes of movement as the queer little sea-worms withdraw into their tubes. Their umbrella-like appendages disappear so rapidly as to seem unreal, a mere figment of the imagination.

Ah, here is something. A gorgeous *Pecten nodosus,* hanging like a pendant, byssus attached to a bit of old spar. You are careful to grasp the specimen firmly before inserting it into your game-bag for big *Pecten* are strong swimmers and once one eludes your grip, it is assuredly lost as a collector's item.

There, in the distance, about shoulder high on the vertical wall is something that seems worth investigating. As you come closer you hardly believe your eyes, for it is a beautiful large specimen of *Murex fulvescens*, all spines perfect and exquisitely formed. In your haste to capture it you scarcely notice the meaty appendage beneath it, although a thought runs through your mind that it is certainly an uncommonly large mollusk for the size of the shell. You reach out your arm greedily to pluck your prize, only to have it jerked abruptly away. Being thrown quite off balance you stumble back a step or two, not fully understanding how such a thing can happen. Just as you are about to make a second grab for the specimen you notice a writhing serpentine arm edged with sucker discs the size of a quarter dollar. With a pulsating movement, it seems to be reaching for something near the shell. In a fit of sudden horror you realize that you had attempted to deprive a huge *Octopus* of his meal! Although the body of the loathsome creature wasn't visible, probably being concealed somewhere within the wreckage, you feel sure that the snake-like arm you saw measured 4 feet. A bit unnerved, you watch, all fear and trembling, not knowing just what to do next. You clear your face-plate with a mouthful of water and discover that the repulsive thing has melted away. As though in a nightmare, you decide that it is time to come back to the surface. In your excitement you have become hopelessly lost, for there is no sun or sense of direction in this underwater world. You reach around for your hose and follow it anxiously towards the descending-line. Don't go too fast, no hurry, and don't step on any of those big black pin-cushions, for those urchin spines are every bit as sharp as they look and burn like fire if they pierce your skin. Watch when you climb over parts of the wreckage, too, because some of those pretty lacy things that look like plants are really animals, stinging hydroids, and can produce an almost intolerable itching if rubbed against exposed human epidermis.

There is so much more we wish you could see on your first dive. If only you could try your hand at collecting *Cyphoma* on the gracefully waving sea plumes and then look for the dainty *Simnia* on the pink and purple fans. Or you could turn small rocks at the edge of the reef and search for choice *Conus nebulosus*. Oh, well, there are a thousand things, but they must keep for the next dive. Being such an ardent conchologist, you've scarcely noticed the fish that swim in such numbers all about you, nor have you paused to drink in the exquisite beauty of their gay flashing colors. While you were kicking to one side the ever inquisitive trigger-fish, a procedure which you found quite useless, morays, their wolf-like heads barely protruding from their rocky homes, watched you with beady eyes. Crawfish lurked under the very wreckage over which you walked, and had you peered down into the dark interstices of the old ship, doubtless you could have made out the dim outlines of a huge jew-fish, hermit that he is, slowly opening and closing his cavernous jaws. Perhaps it is just as well that you were so intent on the mollusks, for had you permitted your eyes to wander you might have seen a ghost-like shark glide silently by, or a barracuda, sleek and terrifying, may have looked you over carefully before he decided upon some other form of food for dinner.

But this time you heave a sigh of relief when the descending-line looms into view. With your precious *Spondylus* safely retrieved you begin the ascent. Slowly you come up, breathing all the while. The top at last! You pass your *Spondylus* to some reaching hand, some one else lifts off the helmet, and feeling like a man who has just returned to earth from a visit on Mars you commence to babble about all the strange things you saw below.

SCUBA DIVING FOR SHELLS IN HAWAII

By Elizabeth Harrison

The moment we slip beneath the surface of the sea in SCUBA gear we enter a new and utterly fascinating world. The basic gear is the same for everyone: face mask, snorkel, fins, compressed air tank, and regulator. After that, the variations in equipment are as numerous as there are divers.

A pry bar to turn rocks or break up coral heads is usually carried; a steel crowbar driven into a wooden pick handle gives good leverage and is fairly inexpensive. A collecting bag, of course; a bag fastened about the waist or looped about the wrist is popular, or a sock (no holes, please!) is sometimes sewed to the bathing suit. Unless we dive from a boat a float is used, usually an inner tube to which a line and an anchor are fastened. This last may be anything heavy enough to reach the bottom and stay there.

A "look box" or glass-bottomed bucket is carried along when diving from a boat; we search for a likely spot by peering through it at the bottom. Once a good area is located, over goes the anchor, on goes the gear and over the side *we* go. From the beach the technique is slightly different; there we don our gear on shore, plop down on our inner tube and snorkel along the surface until a good spot is found. The float anchor is dropped, regulator substituted for surface breathing snorkel and down we go along the line to the bottom, be it 15 to 50 feet or more.

It is standard practice to work the area around the anchor, then carry it to the next spot. One feels more secure knowing that the float is above. In sand patches we fan for sand dwellers with gloved hands (did we mention gloves?) or, if conditions are right, follow the mollusk's tracks. When working on a submerged reef the pry bar comes into use to turn loose rocks, pry up attached ones or break apart those too large to turn. All types of terrain must be searched for each shell has its preferred habitat.

One works at a leisurely pace so as to make optimum use of the precious air, swimming from one coral head to the next with slow and easy kicks of the "flippers."

It takes practice to find shells with SCUBA gear, but once learned there is no other experience in the world to equal this sport. It is a thrill to find *any* shell, be it common *Cypraea isabella* clothed in its coal black mantle or more-than-common *Conus pulicarius* fanned from the sand. To

this diver's mind the ultimate in all thrills is the finding of *Cypraea tesselata,* that living gem of the ocean!

It is with a feeling of disgust that one realizes that the air supply is running out and it is time to surface. As we slowly follow our anchor line to the surface, we always KNOW that we left behind a prize in the coral head we hadn't been able to investigate. But surface we must, once again reverting to the snorkel and float for the swim back to the beach.

COLLECTOR'S ITEMS FROM COMMERCIAL FISHING GEAR

By Lela M. Griffith

Reprinted from *Nautilus,* Vol. 68 (1), July 1954

To us, commercial fishing has always had an important by-product—mollusks and other forms of life from deep water. Our shell collection was actually started, not with shells gathered on the beach and not even with mollusks, but with two species of Brachiopoda snagged on trolling gear some years ago. They were taken in Sechelt Inlet and brought home as curiosities, later to be identified as *Laqueus jeffreysi*, a smooth round brownish lamp shell, and *Terebratalia transversa*, quite heavily ribbed and of a reddish color, each attached to a sponge by a peduncle or stalk. We still have them and to this modest beginning have added from time to time all that our own gear brought up and all that we could persuade anyone else to save of deep-water material.

It is not quite accurate to say the shells were snagged on the gear although once in a while a scallop closes on a hook. What the hook catches as it is hauled along the bottom is much more likely to be a sponge or bryozoan which in turn often brings up the rock to which it adheres; and either the sponge or the rock may carry a variety of shells and other small creatures.

The population of one more or less typical rock consisted of the following assortment: four bryozoans of three different species, one Snake's Head Lamp Shell (*Terebratulina unguicula*), one Little Lamp Shell (*Platidea aneminoides*), two Ridged Clams (*Humilaria kennerleyi*), one Horse Mussel (*Modiolus modiolus*), three Hairy Snails (*Trichotropis cancellata*), one Lyons' Shell (*Lyonsia pugetensis*), and two corallines (*Balanophyllia elegans*). These ranged in size from a 3-inch bryozoan to a Platidea no bigger than the head of a pin. Naturally a good many rocks and sponges are barren, and not all types of fishing gear have hooks, but each has contributed, at one time or another, something besides the commercial product for which it is used.

Aside from those already mentioned, we have had few shells of any value from trolling gear but did pick off kelp, dragged from 6 fathoms near Grant Reef in the Gulf of Georgia, a tiny pearly *Cypraeolina pyriformis,* a snail shaped like an infinitesimal cowry, and one *Clinocardium californiense*, a small cockle with more and finer ribs than the common Basket Cockle.

Seines and gill-nets with their too-large mesh are poor equipment for collecting shells but sometimes they bring up mud and debris, embedded in which there may be specimens. From such a source have come some interesting species, particularly small round mussels (*Musculus nigra obesa*), each in its protecting gob of jelly. These came up in a gill-net in Rivers Inlet. Also from a gill-net but off the Point Grey Flats we obtained a fine little Moonsnail (*Polinices pallida*) and a Bent-Nosed Clam (*Macoma nasuta*); and in Johnstone Straits a Chinese Hat Snail (*Calyptraea fastigiata*) like a conical limpet outside but with a spiral deck inside. These were attached to kelp holdfasts which came aboard in the net. Here in Jervis Inlet a gill-net inconveniently sank when its floats became water-logged, but to make up for the trouble it caused it brought up our first *Cidarina cidaris*, pearly little turbans with spiral rows of beading; and several more of the brown lamp shells (*Laqueus jeffreysi*).

Seines have not yielded much: one hairy brown Horse Mussel (*Modiolus modiolus*) and from Deserted Bay in Jervis Inlet, a number of long slim Jack-Knife Clams (*Solen sicarius*).

Last year a friend gave us a fine big scallop (*Chlamys caurina*), the only perfect specimen we have of this species. Her son brought it home after working on a bottom-dragger in Hecate Strait several years ago. These shells, much sought after by collectors, are commonly taken, I believe, in trawls but, unfortunately, we do not know nor have we been able to contact any trawlers.

Shrimp traps catch no bivalves but snails are sometimes attracted by the smell of the bait intended for the shrimps. From traps put down in a depth of nearly 100 fathoms in the vicinity of Cortez Island we had a donation of 9 specimens of *Neptunea phoenicia,* large handsome brown snails with distinct spiral ribs. And from the same source but taken in Bute Inlet, we obtained one huge Ridged Whelk (*Neptunea lirata*), bigger and handsomer even than its aforementioned cousin. Shrimp traps in 70 fathoms of water off Shannon Creek in Sechelt Inlet invariably bring up a quantity of *Colus morditus* and *C. jordani,* more or less evenly divided as to numbers. They are smooth brown snails, one to 1½ inches, usually partially covered with a black growth and rather difficult to tell apart. With them once was the larger, more distinctive *Colus herendeeni,* with fine spiral lines and a thin olive-brown periostracum. After these aristocrats the take in Jervis Inlet has not been very spectacular, mostly the large hairy Oregon Tritons (*Argobuccinum oregonense*) with sadly worn apexes from being dragged by their owners over rocky bottom, the lowly black Spindle Shells (*Searlesia dira*), and a few all-too-common Dog Whelks (*Nassarius mendicus*).

Although there is no commercial crab fishing in this Inlet we have tried crab traps for snails but with very indifferent success. We are too near the Skookumchuck and the strong tide fouls the buoy line and finally it breaks thereby losing the trap. The odd times it came safely up we got mostly the same old Spindle Shells and Dog Whelks but it did secure one prize, the lovely little Spotted Top Shell (*Calliostoma variegatum*), and

one *Puncturella cucullata,* a limpet-like shell with sharp ridges and a slit at the apex of the cone.

Cod hand lines have supplied us with several scallops each year. Three species are in the Inlet, *Chlamys hindsii, C. hindsii kincaidi,* and *C. hericius,* all in varying shades of pink and all very beautiful. The first two kinds are about 2 to $2\frac{1}{2}$ inches across, the last mentioned a bit larger and more vividly colored with coarse spiny ribs. These are swimming shellfish and when a line drags between the valves they immediately snap shut instead of prudently backing off. Sometimes we get the Ribbed Top Shell (*Calliostoma costatum*) from the stomachs of the cod; the outside layer of the shell is dissolved away by the action of the stomach acid, leaving the pretty pink and blue pearl exposed. Once, in an urn-shaped sponge stuck on the hook, we found a young Octopus (*Octopus hongkongensis*).

The set-line or long line has been by far the most prolific producer of shells, etc. It may be from 100 fathoms to a mile in length, lies on the bottom with short ganglings at regular intervals each bearing a hook; perhaps a thousand on a mile of line. It is lifted by a buoy line and drags a bit on the sand and rock as it is pulled, the empty hooks catching this and that as they go by. At least it used to work that way. For 2 or 3 years now there has been little market for dogfish livers and hence, to our intense regret, no set-line fishing. However, we have had over the years a prodigious haul.

Many of the species from other gear also showed up from the set-line. A few each, *Cidarina cidaris, Calliostoma variegatum, Puncturella cucullata, Colus morditus,* and *C. jordani, Modiolus modiolus,* one only *Colus herendeeni,* and one *Octopus hongkongensis,* the latter from the stomach of a dogfish. A good many each of *Argobuccinum oregonense, Searlesia dira, Nassarius mendicus, Laqueus jeffreysi,* about a dozen *Neptunea phoenicia.* Always a fair supply of the three scallops (*Chlamys hindsii, C. hindsii kincaidi* and *C. hericius*), one notable contribution of 9 specimens, 7 *C. h. kincaidi* and 2 *C. hericius,* these last two from the stomach of a large red anemone, all taken at the same time from approximately the same spot.

The list of those peculiar to the set-line is quite impressive. A tiny brown limpet making its home on kelp, *Acmaea instabilis; Lepeta concentrica,* small, whitish, and limpet-like with faint striations and the periostracum eroded away at the apex; *Solariella peramabilis,* a pearly turban looking like a small tube wound round leaving an open umbilicus; the common little Checkered Littorine (*Littorina scutulata*); the White Slipper Shell (*Crepidula nivea*) oval, clinging flatly, pearly inside with a deck squarely across one end; *Melanella comoxensis,* tiny pink-spired snails (our specimens were picked off an old shoe); *Ocenebra fraseri,* a knobby little fellow with a sort of basketwork sculpture; *Trophon tenuisculptus,* similar to the last but longer and slimmer with an elongated and twisted canal; *Olivella boetica,* the Little Olive, purplish and porcelain-like, one only taken off Scuttle Bay; *Siphonaria thersites,* looking like a brown horn limpet but with a slight groove running from the vertex to the margin inside; *Loligo opalescens,* the slim squid with its opalescent hues.

Bivalves, too, are well represented. Two thin white transparent scallops about the size of a finger nail, *Pecten vancouverensis* and *P. randolphi,* the former with a few roughish lines and the latter smooth; two little brown clams, one with heavy concentric ridges, *Astarte alaskensis,* and one with lighter broken ribs, *A. esquimalti;* small yellowish Kelly Shells (*Kellia suborbicularis*), two juveniles are all we have; *Panomya ampla,* a heavy irregular shell, chalky white in color; *Hiatella pholadis,* an oblong mis-shapen little clam found burrowing into sponges and in crevices in rocks; the white Ridged Clam (*Humilaria kennerlyi*); *Lyonsia pugetensis,* small, silvery, and delicate.

Not off the fishing gear, but on kelp lifted by the anchor, we collected two choice species; from Baker Pass a pair of wee white Gem Clams (*Gemma gemma*) and from Rivers Inlet one fat brown Chink Shell (*Lacuna porrecta*).

So much for what we have. The fishing season is on again and we anticipate what it will bring; perhaps not much but always the chance of something strange. Perhaps there will be set-line fishing again one day. Perhaps we shall meet a cooperative trawler. And who knows? Perhaps this article will inspire some fisherman to save those oddities that come up on his gear. Of course, there is, too, the dredge, but that is another story.

COLLECTING MOLLUSKS FROM FISH

By Arthur H. Clarke, Jr.
National Museum of Canada, Ottawa

One of the most rewarding techniques for obtaining deep-water mollusks is through utilization of the stomach contents of bottom feeding fish. Many new and rare species have been found by this method and it is within the reach of everyone with an active interest in collecting shells.

Back in the pioneer days of malacology when the common marine species of North America were being discovered, naturalists made frequent use of this method for gathering mollusks. During 1838 and 1839, J. P. Couthouy described 23 new species of New England mollusks and one brachiopod which he had found "in maws of fish caught in Massachusetts Bay" and nearby waters. At approximately the same time, Gould, Stimpson, Mighels, Adams, and Linsley were describing many other species taken from fish caught off New England and on the Grand Banks. Many of these mollusks were represented by single specimens which were later lost and have never been collected since.

Even in an area as thoroughly searched as New England, fish are still yielding new and rare species. The first specimen the author ever obtained from fish caught off Massachusetts proved to be new. Yet paradoxically, very few people are presently availing themselves of this productive source.

Validity of Data. Data supplied by early investigators left much to be desired. In most cases no accurate locality description or record of the depth prevailing where the fish were caught was available, and indeed it was felt

that such information would be of little value because the fish had probably travelled a considerable distance since ingesting the mollusks.

W. F. Clapp has shown subsequently that this is probably not the case. In November, 1911, while on George's Banks on a fishing trawler, he found that the molluscan fauna represented in the digestive tracts of fish corresponded almost exactly to the species obtained by dredging at the same locality. This was repeated at a number of stations exhibiting a variety of bottom conditions and supporting different assemblages of species. He pointed out also that the relative position of the shells in the digestive tract gave important information. If specimens were found in the stomach or upper intestine, the fish could not have obtained the mollusks far away from its point of capture.

Depth records are now more easily available than ever before. Most fishing boats employing more than a very few men are equipped with electronic depth finders, and if fish or fish entrails are acquired from commercial fishermen, they will probably know the depth at which the fish were caught and the approximate location. Significant and reasonably accurate data can therefore be easily obtained.

Procuring the Fish. Whether the conchologist catches the fish or obtains them commercially has little bearing on the final result. However, unless your luck is exceedingly good, you probably won't get as many fish as you could obtain from a fishing trawler or gill netter at much less cost.

Practically all fish caught commercially are gutted at sea while the boats are returning to port. Unless you are present while the fish are being gutted, you may find it difficult to obtain the source material you desire, and even if you are on board, the men may feel that you are in their way.

One method that I have found to be most satisfactory is to supply the captain of a small boat with large, covered cans or pails and offer to pay him a reasonable price for the stomachs and intestines of bottom feeding fish. In return, he will probably be glad to tell you the depth, the approximate location, and perhaps even the kind of bottom involved. Do not be discouraged if he tells you there are no shells in the fish, there usually are but he has failed to notice them because of their small size.

Productive Species of Fish. Feeding habits of fish differ considerably. Game fish (e.g. sharks, tunas, sailfish, etc.) will often contain pelagic mollusks such as cephalopods, pteropods, and heteropods, but mackerel, herring, and other small species which feed pelagically will contain very few mollusks.

The best sources of shells are probably those fish that feed on the bottom, especially cod, haddock, and flounder. The following list includes the commoner species of North American marine and freshwater fish known to subsist in large part on benthic mollusks.

MARINE FISH

Skate (*Raja* sp.)
Killifish (*Fundulus* sp.)
Black sea bass (*Centropristes striatus*)
Cunner (*Tautogolabrus adspersus*)
Tautog (*Tautoga onitis*)
Sculpin (*Myoxocephalus* sp.)
Puffer (*Sphoeroides* sp.)
Rockfish (*Sebastes* sp.)
Sea raven (*Hemitripterus americanus*)
Sea robin (*Prionotus* sp.)
Conger eel (*Conger oceanica*)
Tomcod (*Microgadus* sp.)
Cod (*Gadus morhua*)
Haddock (*Melanogrammus aeglefinus*)
Cusk (*Brosme brosme*)
Summer flounder (*Paralichthys dentatus*)
Winter flounder (*Pseudopleuronectes americanus*)
Atlantic halibut (*Hippoglossus hippoglossus*)
Wolf-fish (*Anarhichas* sp.)
King croaker (*Gonyonemus lineatus*)
Ratfish (*Hydrolagus colliei*)

FRESHWATER FISH

Brown bullhead or horned pout (*Ictalurus nebulosus*)
Yellow perch (*Perca flavescens*)
Gizzard shad (*Dorosoma cepedianum*)
Lake whitefish (*Coregonus clupeiformis*)
Buffalo fish (*Ictiobus* sp.)
Redhorse (*Moxostoma* sp.)
Burbot (*Lota lota*)
Freshwater drum (*Aplodinotus grunniens*)
Pumpkinseed or sunfish (*Lepomis gibbosus*)
Goldeye (*Amphiodon alosoides*)
White sucker (*Catostomus commersonii*)

Processing the Fish. If the fish or fish entrails are inspected for mollusks soon after they have been acquired, the procedure will not be particularly unpleasant. In fact, the thrill of anticipation and discovery associated with finding the strange and often beautiful deep-water mollusks will, no doubt, greatly outweigh all other considerations. In cool weather, processing may be delayed for one or two days without undue harm, but after that length of time decomposition begins and hydrogen sulfide starts to form. The shells are not injured but the examination procedure becomes increasingly less tolerable.

Ideally, inspection is best carried out in the open air or in a well ventilated garage or other outbuilding. Equipment should include a table, several flat pans and metal trays, one or two small knives, scissors, forceps,

vials, and jars for specimens, a fine mesh sieve or wire basket, and a large covered container for waste material. A source of running water is desirable, and thin rubber gloves may be used to advantage.

If whole fish are to be inspected, the stomachs and intestines must first be removed, preferably intact to avoid loss of specimens. I have found the following procedure efficient and satisfactory for subsequent examination.

Pick up the first stomach with attached intestines and rinse it gently in a pan of water. Place it on a tray and feel the intestine throughout its length for solid material by passing it lightly between thumb and forefinger. When solid objects are encountered, cut the intestinal wall with scissors and remove them. Many choice mollusks will be found directly in this way. The lower part of the intestine will often be filled with semi-solid fecal material which should be removed and placed in a jar for further treatment. Lastly, cut open the stomach and inspect it for specimens. It is here that the living mollusks, especially gastropods, may be found, although only a small percent of the total specimens will be found in the stomach. As each digestive tract is exhausted, place it in the waste container, rinse off the tray, and repeat the procedure on the next specimen.

When all have been examined, the fecal matter is ready to be processed. Rinse it into a pan partly filled with water, stir the mixture gently to break up lumps, and pour the slurry into a fine mesh strainer or wire basket. Rinse the basket carefully and completely in running water until the rinse water is clear and all soluble or finely divided organic matter is removed. Spread out the washed material on a tray and allow it to dry. It will now be nearly odorless. When dry, inspect under a magnifying glass or low-power microscope for the many tiny and exquisite specimens that will probably be present.

General Remarks. The cost of collecting mollusks from fish is usually much lower than the cost of dredging, and results are often better. Although every fish will not contain shells, many dredge hauls contain nothing but mud and sand. Of course, dredging will capture the larger species not obtainable from fish. but specimens over an inch long have been found in fish and many rock dwelling species may be found which are almost unobtainable by other means.

Vast areas of the world exist where fish stomach contents have never been extensively examined for mollusks. In some other regions, the method has been employed to a limited extent. However, it is certain that no large area exists where mollusks and bottom feeding fish are both found in which collecting by this method would not produce an array of interesting and rare specimens sure to delight any avid shell collector.

REFERENCES CITED

BAKER, F. C., 1916. *The Relation of Mollusks to Fish in Oneida Lake.* New York State Coll. Forestry, Syracuse Univ., 16, No. 21.

CLAPP, W. F., 1912. *Collecting from Haddock on George's Banks.* Nautilus 25: 104.

CLARKE, A. H., Jr., 1954. *Shell Bearing Marine Mollusks of Cape Ann, Massachusetts.* Nautilus 67, No. 4.

CHITONS, THEIR COLLECTION AND PRESERVATION

By S. Stillman Berry

Reprinted from *Mollusca*, Vol. 1, No. 7, 1945

The curious assemblage of mollusks known as Cradle-shells, Chitons or Coat-of-mail Shells holds a particular interest for the student of West American marine fauna, since the group there attains a development in genera and species without parallel save only in Australian waters.

They evince a surprising specificity of habit, and each is rarely, if ever, found outside its own peculiar station. Some species and even genera, for example, are successfully looked for only in the hollows and crannies of rough boulders in the mid-tidal area; some affect the shallow pools which on a rocky shore become accessible to the collector long before the tide has reached its ebb; others occur crowded amongst the mussels and barnacles on jutting headlands exposed to the full power of the surf, while yet others are found only under rocks or in their deepest crevices.

Sandy beaches are generally quite barren of these animals, although one of our species, the giant *Cryptochiton*, occasionally occurs there. Many kinds are to be obtained only from deep water, in quite restricted areas, as in Monterey Bay, where my repeated hauls were quite in vain for several species outside the precincts of a certain bank of hard blue clay, its angular crags often covered by an incrusting sponge of a purplish-rose color not unlike that prevailing amongst several of the chitons found in numbers on such of its fragments as are broken off and brought up by the dredge. Some species are found only at the lowest tides or dredged below tide-mark; others found at such tides are hardly ever dredged; some are very common in the dredge hauls as juveniles (e.g., *Tonicella*) but the adults all seem to have moved ashore. One interesting and not too well understood species (*Cyanoplax lowei*) is hardly known to us except for its frequent occurrence in large kelp holdfasts torn free by storms and cast on shore. On the other hand the zone of such forms as the related *C. hartwegii* and most of *Nuttallina* is left behind in the retreat of even a moderate tide. Several remarkable and astonishing Australian species of *Stenochiton* are found only on certain marine plants such as the eel-grass. No forms analogous to those have as yet been discovered in our waters. None the less, wherever a collector may find himself, he will do well, if he wishes to be sure of obtaining a complete representation of the fauna, to give every possible type of location or habitat which his locality affords an exhaustive search.

On some rocky strands an especially useful method of collecting is to wade out in bathing garb at the lowest tides and lift out rocks of manageable size from as far under water as one can extricate them, bringing them in to shore for examination. Quite rare species or even now and then the great prize of an undescribed one will sometimes be brought to light in this way.

On our coast at any rate we may safely generalize that the most favorable area for chitons is from just above the low-tide line to perhaps

30 fathoms depth, providing that the bottom is rocky or strewn with boulders or rock fragments, or reasonably large shells. Here an abundant harvest is almost invariably to be obtained.

Whether on shore or at sea, I find the same simple collecting outfit indispensable for effective work. This may well include:

1 broad, thin-bladed knife or spatula;
1 old scalpel or pen-knife (for use in dislodgement of the more minute specimens);
A series of small, flat, smooth-surfaced sticks, somewhat like rulers, cut into convenient lengths and of assorted widths (except for *Cryptochiton*, which requires altogether special treatment, a width of 3 inches is usually ample for the largest);
A number of ordinary glass microscope slides;
A plentiful supply of narrow white (or undyed) cloth tape or very soft twine (it is often an advantage to have both);
A few small buckets or jars;
A supply of 70 percent alcohol;
A large bucket or strong canvas knapsack as an all-inclusive and handy container for the outfit.

The animals are easily loosened from the surface to which they cling by a deft insertion of the knife-blade beneath the edge of the girdle, followed by a slightly lifting lateral motion of the knife. Care should be used not to cut or otherwise injure the girdle or to crack the valves. Before it has a chance to curl each animal should then be promptly transferred to one of the sticks of appropriate size (or, if a smallish example, to one of the glass slides) kept well wetted with sea water, gently yet firmly flattened into close approximation with its surface, and, its long axis coinciding with that of the stick, there bound in position by several rapid turns of the tape or cord. The disengaged animal will usually begin to bend in upon itself almost immediately, and it sometimes happens, with the best of precautions, that this will proceed past the stage when it will readily yield to straightening, while a particularly recalcitrant individual may curl itself up into a solid, armadillo-like, protective ball before it can be bound to its stick. In such event, any attempt to straighten it out by sheer force can only terminate imperfectly at best, and is considerably more likely to break the valves or their insertion-plates or otherwise result in irreparable disaster to the specimen. A much better recourse is to drop all such animals into the collecting bucket forthwith and to cover them with sea water. There they are likely to resume their normal extended state within a short time, and can be duly cared for upon the collector's return to his base. The more stubborn individuals may then be transferred to a quiet bowl of clean sea water, where, if uninjured, they will in time usually resume the normal position. In tying the chitons to the sticks or slides a convenient and space-saving practice is to bind down two or more specimens at one time by placing them simultaneously on opposite faces of the stick. Before winding them tightly on one should assure one's self, as has already been indicated, that close adhesion has been secured at all points by gently sliding the specimen or otherwise carefully manipulating the girdle until the animal is perfectly even and flat. As each stick or slide becomes filled to capacity, its binding tape should be firmly tied by a single bow or draw-knot, and it may then be dropped into a jar of weak alcohol or even replaced in sea

water pending return to base-camp or laboratory. Here each stick and slide should be carefully examined to ascertain whether all the animals remain well tied or have perchance begun to slip their moorings, as they sometimes do by crawling from under the cord. All such should be retied and then the whole may be immersed in weak alcohol for an hour or two, or in ordinary tap water for a longer period. My own results have been best under the former procedure, after which the animals may be passed through two or three changes of alcohol in ascending concentrations, remaining in each for a period of perhaps 10 or 12 hours, until they are brought into a solution of 70 to 75 percent strength, which is sufficient for their permanent preservation. More concentrated solutions of alcohol only serve to harden and warp the tissues and should be avoided. After the specimens are in the 70 percent alcohol they may be untied from their temporary substrata and will thereafter retain their natural outlines if allowed to lie free and not too closely crowded in the preserving medium.

In my experience formalin is an exceedingly unsatisfactory, even objectionable preservative for chitons. Its advantages in the way of retaining beautiful colorings are far outweighed by the damage done through softening or dissolution of important calcareous parts. *Do not use it.* Should it chance that nothing else is available, however, no pains should be spared to transfer the specimens preserved in it to 70 percent alcohol at the earliest opportunity. Methyl (wood) alcohol likewise is not to be recommended as anything but a wretched makeshift, while even denatured ethyl alcohol is very much less satisfactory than the pure article, particularly if the denaturant used is appreciably acid in character. If the specimens are desired for histological work, more careful methods of fixation and hardening should be undertaken, though even for this purpose I have sometimes had surprisingly good results with no more refinement of method than the simple procedure outlined. Ryder, in Dall's well known pamphlet of "Instructions for collecting mollusks" (1892: 43), gives some excellent "Directions for preserving the soft parts of Mollusca," and to these as well as some of the better current manuals of microscopical technique I would refer the reader who desires to pursue the matter further.

If it be desired to preserve the specimens in the dry state, the animals may be killed in weak alcohol or fresh tap water as previously suggested, then unbound, the soft parts carefully cut away with a sharp knife and the "shell" (i.e. the neatly cleaned valves enclosed in the girdle) firmly retied to its stick in the flat natural position of the animal until the girdle has *thoroughly dried,* and there is therefore no further risk of the specimen curling or warping. Specimens dried on glass occasionally adhere so strongly to the smooth surface that it is a little troublesome to lift them off undamaged, but the extra pains are worth while in that the girdle of such specimens remains expanded and does not wrinkle against the valves as in the common run of collectors' shells. Exceptionally beautiful museum specimens are often the result. I do not consider the frequent practice of some collectors of brightening up their specimens by the application of thin coatings of vaseline, oil, or varnish to the dorsal aspect of the shell as one in any

way to be recommended. Not only does it often lend an unnatural waxy appearance, but specimens so treated are prone to become increasingly unkempt and frowsy with adhering dust. Mounting likewise is inadvisable if it entails solid fixation to a card or tablet, as the interior of the shell in chitons is often hardly inferior in interest and beauty to the dorsal surface, and it is better to keep one's specimens in such a manner that they may readily be subjected to examination from all aspects. My own practice is to use shell-vials for the smaller shells, cardboard trays for the larger, and to resort to the more expensive glass-topped boxes only for certain special subjects. Certain quite crucial classificatory features of chitons are found in those marginal structures whereby the valves interlock with the girdle and with one another, and are well seen only if the valves are entirely disarticulated. It is therefore wise to prepare such disarticulated series for as many species as one's material permits, marking those valves, the identity of which is not easily apparent from their form, with small Roman numerals in India ink according to their position, III, IV, V, or VI. In disarticulation it is necessary to be extremely careful not to break either the insertion teeth or the sutural laminae, and it therefore becomes the part of wisdom to take the precaution of first soaking up such specimens in warm fresh water in order to reduce the extremely tough resilience often possessed by the girdle to something resembling flaccidity. The freed girdle may in its turn be used either in the preparation of whole mounts in balsam or mounts of the loose scales. I usually like to prepare slides of both categories as well as of the radula, not failing to record the exact animal or shelly parts from which they were taken. I also occasionally make clear mounts in balsam of the entire animal, shell and all, where the animal is small enough to clean and mount well. One learns much from these.

The principal enemies of a collection of chitons kept in the dry state are dirt and the common museum beetle. Both hazards can be reduced to a minimum by keeping the collection in a cabinet with tight drawers, with a generous and frequently replenished scattering of naphthalene flakes or moth-balls in each drawer. It goes without saying that the more careful and thorough the initial preparation and cleaning the less subsequent trouble there will be.

However this may be, the desirability of preserving a fair proportion, if not the whole, of any given catch in alcohol, wherever scientific studies are subsequently to be carried out, can not be too strongly emphasized. By so doing a collector will certainly find his efforts to count far more in a lasting way. Many important characters of chitons are greatly obscured and sometimes lost entirely through subjection to the process of drying. This in some cases involves even such fundamental matters as *family* characters, and many a scientifically priceless specimen has lost a large part of its value because of the collector's neglect or ignorance of this truth. In consequence, there is no doubt that the lack of material suitably preserved in alcohol has, more than any other single circumstance, delayed our understanding of this extraordinary group of creatures and has involved their study with much needless uncertainty and confusion in the literature.

The most particular pains should be taken with all the "bearded" species, and no chiton with "whiskers," even the smallest, should be dried and cleaned unless you are quite certain that it is some common and well-known form of which you have plenty to spare; rather it should be killed carefully in the expanded condition, having bound it so as not to injure any specialized setae which may be borne by the girdle, and then put up in alcohol until it can be studied by some competent student. Cotton, owing to the inevitable entanglement of its fibers in the bristles, is not a satisfactory packing material for specimens of this type; cheesecloth or some light, non-absorbent paper is better for the purpose. Many of our bearded species are so poorly understood that even an inexperienced collector has a chance of picking up something which promises, at least potentially, to effect some real addition to knowledge. It will then be realized that it is far better to make the slight additional effort necessary to put up a relatively small collection in proper shape, whether it is to be kept in alcohol or dry, than to take so large a mass of material that none of it can be handled decently and a mass of misshapen, dirty, ill-smelling cadavers, the bane of whomsoever is so unfortunate as to have to work them up, is the only result. Such material is costly to the time, patience, and efficiency of the student infinitely in excess of the little trouble the added care in the field would have entailed. A chiton collection which is in the main a slovenly mess possesses no attractiveness and little value.

Allusion has already been made to the rare occurrence of individuals possessing either more or less than the normal eight valves. These are of interest to the teratologist or pathologist rather than to the systematist, but the curious and uncommon of whatever nature always seems to possess intrinsic appeal to the collector, and as these specimens are surprisingly easy for most people to overlook unless trouble is taken actually to count each set of valves, it becomes a source of considerable entertainment to keep a weather eye out for them, remembering that they are easier to detect when working over one's catch in the laboratory or at home than they are amid the swirling rush of the rocky shore. Specimens with supernumerary valves appear to be by all odds the rarest; a very few with 9 valves (I, myself, have seen precisely *one*), and none, so far as I can learn, with more than 9 are recorded in the literature. Those with valve deficiencies on the other hand are of very much more frequent occurrence. Most large collections can boast a few specimens with 7 valves, occasionally one with 6, and, more rarely, one with 5. The most common type of apparent deficiency is not due to any actual lack of a segment, but is purely superficial, having been caused by some early mechanical injury as a result of which two or more valves have undergone more or less complete fusion. Careful examination of the structure of the valves, particularly of the articulamentum, will usually reveal the presence of parts at least of all 8 of them, and pretty well indicate what must have taken place. Outright deletion of valves is a much rarer phenomenon, and when this has occurred it is difficult or even impossible to determine which valve is the missing one.

A word, too, should be said on behalf of the very small chitons. Not only are the youngest stages of growth frequently quite different in appearance from the adult condition, and very insufficiently known for most of our species, but many forms are of small size even when fully grown, and some of these are so difficult to recognize with certainty in the field that the collector can not go amiss in saving every specimen encountered. I here refer simply to the little fellows which are commonly to be found in company with the adults of the same or different species, yet the extremely minute post-larval stages are likewise of interest. Collecting these requires somewhat special methods, which will quite likely not be found exactly similar for all species. Through the courtesy of both the parties concerned I repeat a quotation in my former paper of an instructive paragraph from a letter on this subject written to Mr. Emery P. Chace by Dr. Harold Heath whose experience has been large in this field: "I have collected hundreds of small chitons, many of them not over 1/50 of an inch in length, in the following way: In pools and from cliffs where adult and fairly well grown chitons abound I chisel off bits of stones, corallines, mussels supporting worm tubes, etc., and place these in a bucket or glass jar and place it in a dark cool place. Do not let any water remain in the bottom of the vessel; merely keep the specimens moist with the water that clings to them. After 24 hours or so the chitons will wander out from cracks they occupy and can be located with a hand lens. At first I found this pretty slow work owing to scarcity of materials, but since I have located rich districts and can find at least 100 in every bucketful."

SHORT NOTES ON CHITONS

For the smaller varieties of chitons, nothing better can be found on which to stretch them while in the process of drying, than the common wooden tongue depressor found in every physician's office, though some collectors favor the use of narrow strips of glass, maintaining that the chiton slips into the desired position more easily by reason of the smooth surface. These collectors usually use narrow strips of cloth instead of cops to bind the chiton to the glass. For larger chitons, lath or other flat wooden pieces should be employed, and it is not well to remove the specimens until fully dried. If it is desired, the bodies may then be removed from the shelly plates. In some instances, the bodies of the larger chitons are removed as soon as the specimen is taken, using a sharp knife, and the specimen is placed at once upon the stretching board. In case this is impractical, as soon as the collector can conveniently do so, the living chiton should be placed in a vessel of sea water and set aside.

Eventually, most specimens will uncurl and they may be placed upon the stretcher and tied firmly with string. The smaller chitons may be brought back in vials of sea water and mounted on the stretcher at the collector's convenience. Smaller chitons may be removed from the rock with the blade of a small pen knife but with the larger ones, a heavier knife is necessary. If the collector is observant, he may determine which

end of the chiton is the head, and apply the knife at the *other* end. They are much easier to remove from the rock in this manner. Chitons are unusual mollusks and certain procedures which might achieve results with other mollusks do not seem to apply to them. For instance, should the collector desire to study the living mollusk in action, it is advisable and necessary that the vessel in which it is confined be kept absolutely quiet. To those who have patiently (more or less) waited for a frightened chiton to unroll so that it might be placed upon the stretching board, and have been exceedingly careful that the specimen be undisturbed, it will be good news to learn that if the vessel containing the specimens be gently tipped backward and forward so the specimens are caused to roll about, in a surprisingly short time, every uninjured chiton will unroll and attach itself to the bottom of the vessel and it can be easily removed and placed upon the stretcher.—B. R. Bales, *1941 Ann. Rept., American Malacological Union*

". . . In connection with the discussion regarding the preparation of chitons, I take the liberty of outlining my own technique: the animals are placed in a pan of fresh sea water to relax. When well flattened out they are picked up quickly and held in the hand and worked a bit while being held under a tap from which is flowing water as hot as the hand can bear. They die very quickly and are then flattened down to a narrow strip or shingle by strips of muslin, after which they are placed in a dish of formaldehyde to harden. The following day they are removed from the strips and cleaned of their internal organs. They are then tied back in place and put in a solution of formaldehyde to which about 10 percent of glycerine has been added. Remove from the solution and let them remain on the strips until dry. The specimens retain sufficient of the glycerine to cause them to remain slightly flexible and they do not develop the shriveled appearance of ordinary specimens."—Prof. Trevor Kincaid, *Min. Conch. Club of S. Calif.*

Now about chitons; the tying down, careful cooking, cleaning and retying which are necessary to make good specimens are so much more bother than cleaning other shells that I am much inclined to say, "If you won't do this extra work, please let the poor things alone!" The tightly curled lumps which are sometimes seen in collections tell very little of chiton relationships or their real beauty. Gulls sometimes pry *Mopalias,* especially *M. muscosa,* off the rocks and eat much of the foot. No use to try to use these shells except as disarticulated valves, for no amount of cooking or patient flattening will relax them; they are permanently cradles. *Lepidochitona lineata* is common almost everywhere north of San Luis Obispo and is not fussy about its position; it may be on the top, side or bottom of a rock, and from mid-tide on down. The dark-colored form with orange-barred girdle is from Washington only. *Cryptochiton stelleri* is best taken when and where you can, then laid out in the sun on its back to die before an attempt is made to clean it. Drying is a slow, smelly process at best. The best preparator I know cleans out the inside of the shell,

packs it with newspaper to absorb the water from the flesh between the mantle and the valves and ties it down to a board. The paper packing holds the shell in shape but has to be changed 2 or 3 times a day. Most *Ischnochitons* are light-sensitive and one must turn rocks to find them.—Elsie M. Chace

COLLECTING SHIPWORMS

By Ruth D. Turner

Special publication No. 19, Limnological Society of America, June, 1947

Shipworms are pelecypod mollusks belonging to the family Teredinidae including the genera *Teredo, Bankia, and Nausitora.* They are most closely related to the Pholadidae, another family of boring mollusks. They are exceedingly important economically, especially in the tropics where any unprotected waterfront structure made of wood may be destroyed in less than 9 months. In the course of their early development, shipworms have a short free-swimming period during which they are easily distributed by ocean currents. When ready to begin boring they attach themselves by a single byssus thread and then start penetrating the wood, making a minute opening where they enter. Shipworms grow very rapidly and may reach a length of 4 inches in a month; thus a piling which has been heavily attacked by these borers becomes a hollow shell in a remarkably short period of time.

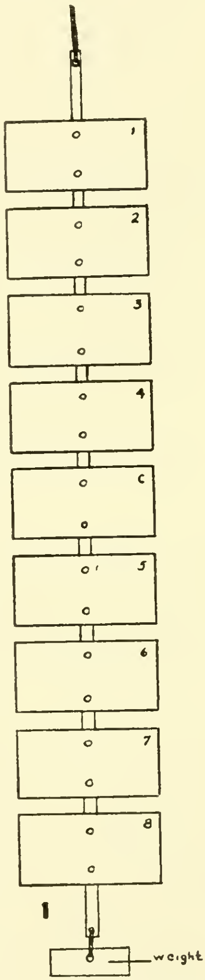
Though volumes have been written on the history and economic importance of marine borers there is still surprisingly little known about their life history, ecology, and distribution except for *Teredo navalis* Linné and *Bankia gouldi* Bartsch, the two species which were so carefully studied by R. C. Miller and C. P. Sigerfoos, respectively.

The taxonomy of the group is still in a confused state as so much of the early work was done with dried specimens obtained from drift wood and several species were named from shells alone. Most of the characters which differentiate the genera and species in this family are invested in the pallets and largely in the periostracum which covers the calcareous portions of the pallets. It is essential, therefore, that only fresh specimens preserved in glycerine alcohol be used for study as the periostracum sloughs off when the pallets become dry. Distributional records should be taken only from collecting boards or permanent structures as these borers are easily transported from one locality to another by drift wood.

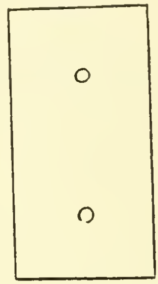
A monthly collecting panel is made up of 6 to 12 boards and a control supported on an iron bar and suspended in a vertical position with the bottom panel 2 feet above mud line. The boards should measure 12 x 6 x 1 inches and be made of pine or other soft wood free from knots. They should be fastened to the back board or iron bar about 2 inches apart with brass bolts. The boards on the panel should be numbered consecutively from top to bottom (see figure 1), the control being placed in the center. Thus on a panel having 8 boards the control would be placed

between numbers 4 and 5. After one month, board No. 1 and the control are removed and taken into the laboratory for study and new boards are put in their places. At the end of the second month, board No. 2, which has been submerged for 2 months and the control, which has been submerged for one month, are removed for study and new ones put in their places. The following month, board No. 3, submerged for 3 months and the control, submerged for one month, are removed and replaced by new ones. This procedure is continued down to the last board which has now been submerged for 6 or more months and the control for only one month. From this series of boards it is possible to ascertain the speed of growth of the borers over the breeding seasons.

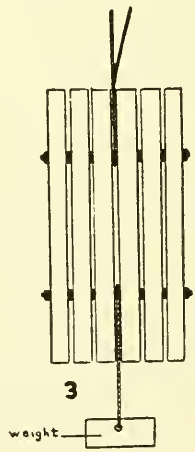
In northern waters a collecting panel having 12 boards may be successfully used to give a growth picture over a period of a year. For comparative studies several panels should be submerged at the same time in any given region and the collecting should be continued over a period of several years as conditions and the extent of the attack seem to vary markedly from year to year. In tropical waters, however, a board one inch thick would probably be destroyed in less than 6 months. Consequently, in order to get a continuous picture throughout the year, it may be necessary to submerge panels having only 6 boards or less and run 4 or more panels concurrently. Thus the first panel would be submerged in January and run to June, the second would run from March to September, the third from May to November and the fourth from July to January. The duration of submergence and the exact depth at which the panels are hung must be determined by the individual doing the collecting as local conditions are so exceedingly variable.



1



2



3

Fig. 1.—Monthly collecting board designed by Dr. W. F. Clapp, Clapp Laboratories, Duxbury, Mass.

Fig. 2.—Laminated collecting board. Face view.

Fig. 3.—Laminated collecting board. Side view.

Before submerging monthly collecting panels it may be well to get a vertical picture of shipworm distribution for the locality by using a Special Collecting Board. This is nothing more than a long strip of wood which extends from the mud line to high water, from which it is possible to learn the exact depth at which the borers are most active. While this is usually near the mud line, there are many exceptions and sometimes the attack is more severe at the surface.

The laminated collecting board is actually a trap for catching specimens and is used mainly for obtaining specimens for taxonomic studies. The board is made up of 6 or more layers of soft, straight-grained wood 12 x 6 x ½ inches with brass or galvanized iron washers separating the layers, to produce cracks large enough so that the shipworms will not cross from one layer to the next. Consequently the borers form long straight tubes and, as the wood is thin, they are easily extracted. The laminated collecting board should be suspended in the region of most severe attack, usually near the mud line. It should be examined every 2 weeks in warm or tropical waters, where destruction is more rapid and removed for study when the attack has progressed sufficiently.

The best specimens are obtained if the animal is dissected out as soon as the board is removed from the water, or, if this is impossible, the board should be submerged in 70 percent alcohol for a week and then shipped to the laboratory wrapped in a cloth saturated with alcohol. Once the specimens have been extracted from the wood they should be preserved in a mixture of 4 parts alcohol (70 percent) and one part glycerine. This keeps the periostracal margin of the pallets soft and pliable and, should the alcohol evaporate, the glycerine will keep the pallets moist for some time. The shells and pallets of each specimen should be kept together in a vial and all the specimens from one board should be given the same number.

Permanent slides, for ease in studying the pallets under the microscope, may be made by mounting the pallets in "Diaphane." They may be mounted directly from glycerine-alcohol, or, if fresh specimens are used, the pallets should be put in 75 percent alcohol for at least 24 hours. Magnification of 10 to 24 diameters is sufficient for identification in most cases.

Ecologists interested in other marine organisms such as algae, encrusting and filamentous bryozoans, tunicates, barnacles, and such mollusks as *Anomia, Ostrea,* and *Mytilus,* may find the use of these collecting boards easily adapted to their needs. A checklist of the specimens removed from the surface of panels over a period of a year includes many species in all of these groups.

REFERENCES

ATWOOD, W. G. and JOHNSON, A. A., 1924. *Marine Structures, their Deterioration and Preservation.* Nat'l. Res. Council, Washington, D. C. (Biological section, pp. 6-76, 12 plates, by W. F. Clapp, C. A. Kofoid, and R. C. Miller).

BARTSCH, P., 1922. *A Monograph of the American Shipworms.* Bull., U. S. Nat'l. Museum, No. 122, pp. 1-48, 37 plates.

CLENCH, W. J. and TURNER, R. D., 1946. *The Genus* Bankia *in the Western Atlantic.* Johnsonia 2, pp. 1-28, pls. 1-16.

HILL, C. L. and KOFOID, C. A., 1927, *Final Report, San Francisco Bay Marine Piling Committee.* (Section on Teredinidae, pp. 188-300, 51 pls., by C. A. Kofoid and R. C. Miller).

SIGERFOOS, C. P., 1908. *Organization and Late Development of the Teredinidae, or Ship-Worms.* Bureau of Fisheries, Document No. 639, pp. 193-231, 14 pls.

OPISTHOBRANCHS

The most useful preservative is 70 per cent grain alcohol. Some soft or gelatinous animals must be allowed to remain 2 to 6 hours in alcohol of 35 to 50 percent, and then transferred to that of 60 percent, and finally to that of 70 percent. It is inadvisable to use formalin (5 percent) or formaldehyde, except for a few weeks in case alcohol is not immediately available. An excellent and detailed account of preserving and narcotizing molluscan animals is found in Part M, Bull. U. S. National Museum, No. 39 (1899), "The Methods Employed at the Naples Zoological Station for the Preservation of Marine Animals," by SALVATORE L. BIANCO, translated by E. O. HOVEY.

NUDIBRANCHIATA

By G. DALLAS HANNA

Reprinted from *Nautilus,* Vol. 68 (3), January, 1955

While working in southern Alaska in 1946 some experiments were made in an endeavor to kill and preserve some nudibranch mollusks in a fully expanded condition for Dr. F. M. MacFarland. It is well known that these animals are prone to shed appendages and contract badly when disturbed by the usual methods of preparation such as anesthetizing.

One method which promised success could not be carried to conclusion through lack of facilities and it was not until July 1954 that the subject could be taken up again. The Arctic Research Laboratory at Point Barrow offered ideal conditions in this respect and it was found that the local nudibranchs which were obtained incidentally with marine geological work could be killed and preserved fully expanded and with all appendages intact. The method consisted of putting the specimens in a vessel of normal sea water sufficient only to permit them to crawl about quietly. The vessel was then transferred to the freezing compartment of a refrigerator or a deep freeze and the water was frozen solid. All specimens which have been tried have shown not the slightest tendency to contract or to disengage parts. Upon removal from the freezer I have added alcohol at times and formaldehyde (4 percent) at other times. In either case, as melting proceeded, nothing happened to the specimens; they were killed in the same attitude in which they were frozen.

In view of the simplicity of the process it is interesting to speculate upon the possibility of using it for gastropods and such marine animals as sea anemones which are prone to contract upon the slightest provocation.

COLLECTING NON-MARINE SHELLS

FRESH WATER SNAILS

By Frank C. Baker

Reprinted from 1941 Annual Report, American Malacological Union

Fresh water snails have attracted attention for years and many quite extensive collections have been gathered which are of considerable scientific importance. Directions for collecting these inhabitants of the waters and preserving them for the cabinet are not usually available, and possibly many amateurs have been deterred from making such collections for lack of proper directions. The methods of collecting and preserving these snails are simple and are briefly described herewith.

Where Fresh Water Snails May be Found. Fresh water snails may be found in almost any body of water, even the ephemeral pools of meadows and woodlands. There is scarcely a river, creek, pond or lake that does not contain one or more species of snails. Some species, as the pond snails, *Lymnaea* and the planorbids, prefer quiet bodies of water where food is plentiful among the aquatic vegetation. Other snails, as *Amnicola, Goniobasis* and *Pleurocera,* prefer the shores of rivers. In some rivers, as in the Wabash in Indiana, the snails live in shallow water on ledges of limestone or other rock which extend far out from the shore. Such a situation occurs at New Harmony, Indiana, where the father of American conchology, Thomas Say, made many of his collections.

Lakes usually contain many species of snails which live among the aquatic vegetation near the shore or on rocky beaches. Some of the lymnaeas, planorbs, and physas may be found in such habitats. Often beach pools, areas of water behind barriers which have been formed by the waves of the lake, afford good collecting localities. In America snails are not found in the deep part of lakes, as is the case in some European and Asiatic lakes (Lakes Balaton, Baikal, Léman, and others), but are confined to the limit of rooted vegetation, not to exceed 15 feet in depth. The great majority, however, live in water 6 feet or less in depth. Roadside rills where there is little water and much vegetation may contain several kinds of small snails, as *Menetus*, *Fossaria*, and *Planorbula.*

Snails are not, as a rule, found in cold lakes at high altitudes or in cold, swiftly flowing streams like those in the New England states and in

the Rocky Mountains. Few or no snails will be found in waters polluted by sewage or manufacturing wastes. A safe admonition to the amateur snail hunter, however, is to look everywhere for snails where there is water. Even wet meadows and the damp shores of ponds and rivers may harbor forms of the small lymnaeids called *Fossaria*. Fresh water limpets (*Ferrissia*, etc.) may often be found in dead clam shells or on rocks.

How to Collect the Snails. Collecting fresh water snails is usually a simple process much more easily accomplished than collecting insects, especially butterflies. They do not fly away and are easily approached for capture. Thanks to one of our oldest members, Dr. Bryant Walker, now gone from among us, who lived in Detroit, Michigan, a useful dipper was invented which is fittingly called a Walker dipper or dredge. It is so efficient that usually no other implement is necessary. This dipper is about 6 inches in diameter at the top and 5 inches in diameter at the bottom, with a depth of about 3 inches. The bottom is covered with copper wire screening of a sufficiently large mesh to allow the mud and water to run through and retain the shells. It is fastened to a handle 5 or 6 feet in length. A broom handle often makes a good handle. The dipper should be made of copper to prevent rusting. If copper is not available then the sides of the dipper may be made of tinned iron and the bottom may be of copper. A dipper of this kind has been in use by the writer for several years and shows no indication of wearing out. I feel sure that the museum of the University of Michigan would be willing to furnish specifications for this dredge or dipper and it could be made by any good tinsmith.

With this very efficient collecting apparatus there is little difficulty in sweeping any body of water for possible snails. It may be used on the shore of lakes and ponds, to explore mud holes and small streams or sweep the bottom of a lake in water down to 6 feet in depth. It is excellent for sweeping through vegetation in a lake or river, the snails falling into the dipper from which they are easily picked out. For collecting snails in large areas of vegetation in lakes or ponds, as in the pond weeds (*Potamogeton*), it is best to pull up some of the vegetation and place this in a large pail. Washing and shaking this vegetation in the pail will dislodge the snails and often several hundred will be found in the bottom of the pail after this process. Pond lily leaves, and also the stems of sedges (*Typha*, *Scirpus*, etc.) should be carefully examined for small snails, especially the little fresh water limpets, *Ferrissia*. Many larger snails, as *Physa*, lymnaeids, and small planorbids, as well as *Amnicola*, may also be found on lily leaves. Most lake collecting should be done from a row boat. In some localities the vegetation may be pulled to shore with a rake.

Such large snails as *Campeloma* and *Viviparus* may be found by running the hand through the mud and sand bordering the shores of lakes and rivers where they live, often in large numbers. The Walker dipper is also useful in such places. From rocks on shores of rivers and lakes the snails may be picked by hand. This is especially true of *Goniobasis*, *Pleurocera*, *Somatogyrus*, and other snails found in our mid-western streams.

Containers for the snails as they are collected may be of various types. If the collecting is being done from a row boat a pail, or several small pails, may be used. Empty tin cans, from which the cover has been removed by a modern can opener and the edge is smooth, are excellent, and specimens from different localities or habitats may be separated, as is always desirable. If one is traveling overland, either tramping or by the ever useful family auto, the containers may be some of the wide-mouthed bottles for pills, which have screw stoppers of hard rubber. Several of these may be carried in large pockets or in a canvas bag which may be slung over the shoulder. If the collecting is by auto the cans mentioned for lake collecting may be used. Often the jars (pint) used for canning fruit are useful for this purpose.

In deep water an Ekman dredge made of brass is necessary, but this is rather complicated and the average collector will scarcely find use for this apparatus.

How to Prepare Snails for the Cabinet. It is of the first importance to clean and prepare properly the snails to be preserved. The small species, such as *Amnicola, Valvata, Gyraulus*, etc., may be placed in a solution of about 75 percent grain alcohol. The snails will retract well within the shell and away from the aperture and the operculum of such genera as *Amnicola* and *Valvata,* which should be saved in all cases, will be preserved. The snails will die and may be dried on blotting paper. They will leave no offensive odor.

Larger species, and those small species from which the animal can be easily removed, should be killed by immersion in boiling water for a few minutes. The animal may be extracted with a dissecting needle, which may easily be made by forcing the eye-end of a medium sized needle into a handle of soft wood, the handle to be 4 or 5 inches in length. The bodies of the snails will easily pull away from the shells if the needle is pushed firmly into the snail's body and the shell is given a slight twist in the opposite direction. A pair of small forceps, which should be an indispensable implement of every collector's outfit, will also help in extracting the dead bodies of the snails.

In such large snails as *Campeloma* and *Viviparus*, as well as the elongated snails of *Goniobasis* and *Pleurocera*, the body will often come away minus the liver which remains within the shell. For cleaning these snails a wire bent in the form of a corkscrew will be found helpful. This should be sharpened at the end. The writer has used a small fish hook for this purpose. A syringe is useful to wash out the animal matter from the larger shells. Every effort should be made to remove all of the animal possible from the shell to avoid disagreeable odors. In cleaning the large snails, if you hold firmly to the body with the needle or corkscrew apparatus and carefully twist the shell the body of the snail will usually come away easily.

If there are incrustations of foreign matter on the shells, especially the larger species, these may be removed by brushing with an old tooth brush. Sometimes algal lime incrustations will need to be scraped off with a knife.

In some cases it may be best to remove the incrustations by the aid of oxalic acid. This should be done carefully by brushing on the acid with a camel's hair brush and then the surface washed with water. Dipping in the oxalic acid may be necessary and in this case the whole shell should be immersed for a few moments and then washed in cold water to remove the acid, which acts very quickly on the limy shells.

The operculum of the larger shells should be preserved by cutting it away from the muscular foot. All traces of flesh must be removed from the under side of the operculum. It should be dried and placed on a bit of cotton in the aperture of the shell from which the operculum originally came. This is important. All large shells should be carefully dried by natural, not artificial, heat. Do not place snail shells on a hot stove or heater or in the oven. Room temperature is sufficient. *Campeloma* and *Viviparus* may be rubbed with a cloth slightly moistened with vaseline to retain the original luster of the shell. All excess vaseline should be removed or the shell will feel greasy. This treatment also helps to keep the epidermis from cracking and peeling.

The little limpet snails, *Ferrissia,* should have the animal carefully removed from the shell with the fine point of a dissecting needle. These little limpets are usually coated with algae or lime and may be cleaned by being allowed to float, upside down, in the surface of a small quantity of oxalic acid, after which they may be washed and carefully wiped with a camel's hair brush. The shell may be easily cleaned if held, bottom upward, on the tip of the index finger.

For more extensive information on collecting and preserving mollusks the reader is referred to the following paper in which there is, also, a bibliography of other papers relating to this subject.

Preparing collections of the Mollusca for exhibition and study. By FRANK C. BAKER. Published in the Transactions of the American Microscopical Society, Volume XL, No. 1, pages 31 to 46, 1921.

TRAPPING FRESHWATER SNAILS

By Leonard N. Allison

Reprinted from *Science,* Vol. 95, No. 2457, pp. 131-132, 1942

An efficient method of collecting the snail, *Campeloma* sp. in streams was found during a study of the life history of the trematode worm *Cercariaeum constantiae* Mueller. Since *Campeloma* habitually burrows, the collection of these snails in quantity by screening consumes much time and is hard work. While collecting these snails in the Huron River near Ann Arbor, Michigan, I noted that they were frequently found in considerable numbers around dead and decaying organic matter. To determine the time required to accumulate a quantity of snails, a dead fish weighing a pound was placed in the mud where earlier collections had been made. Ten days later, an area of approximately one foot square and 6 inches deep around the fish yielded 78 *Campeloma,* a number far exceeding those taken in similar, but unbaited situations.

Dr. G. R. La Rue suggested the use of dung in place of dead fish, as he believed that these snails might be coprophagous and become infected by eating trematode eggs voided in feces. Accordingly, small cloth bags of feces were planted in the mud and found to be equally as effective as the dead fish, and more conveniently handled. Dung of dog, cat, ferret, muskrat, and chicken was tried. After a few preliminary experiments, chicken dung was used exclusively. It was dried before use, which eliminated objectionable odors and permitted it to be packaged in quantity and stored to be used as needed. Dried dung was as effective as fresh.

To make a snail trap, a quantity of dried chicken dung is placed in the center of a cloth 9 inches square, the corners twisted together and tied with heavy cotton twine, leaving free enough to tie to a stake. Double thickness of washed cheesecloth is ideal; heavier cloth resists rotting for a longer time but also retards the passage of the fecal extract. The twine should be capable of resisting rotting in water, since these packets remain effective until their contents are gone. The packets are tied to stakes and placed in suitable habitats for *Campeloma.*

Choice of location is important. In streams these snails frequent shallow, mucky situations and plantings should be made here; gravel areas in deep water should be avoided. When properly planted, the packet should be half-buried with the stake projecting above the water level far enough to be easily recognized. In areas frequented by many people, the plantings should be inconspicuous to prevent possible interference. This can easily be accomplished by using dark-colored cloth and stakes made of tree branches; in summer, willow is especially suitable because the leaves remain green and willow looks natural along the banks of streams.

The trap remains effective for approximately 6 weeks, but to get the best results the location should be changed every 10 days or 2 weeks. The snails are collected by removing the trap and screening the mud from an area about 15 inches square around it by means of a screened scoop or spinach strainer.

It was suspected that in streams the current might carry fecal extract which the snails followed to its source at the trap. This idea was tested by planting marked snails at various distances, 2 to 15 feet, upstream, as far as 20 feet downstream, and 10 feet across the stream from a trap. In collections made at weekly intervals for 5 weeks, 28 of the 67 snails (41.7 percent) planted upstream, 24 of the 86 (26.7 percent) planted downstream, and 2 of the 9 (22.2 percent) planted across the stream were taken at the trap. Practically the same number of snails moved to the trap from 15 feet upstream and 20 feet downstream as from 2 feet up and downstream. My data indicate that the snails move at random. Once arrived at the trap, however, they tend to stay as long as the food supply lasts.

In lakes the traps proved ineffective. Experiments to determine the reason for this have not been carried out. All the lakes tried had bottoms of sand underlaid by muck which perhaps provides sufficient food for

Campeloma to nullify the effects of food concentrated at traps. Traps should be tried in lakes with clean, sandy bottoms.

In the streams tested the traps are specific for *Campeloma.* Other species of snails are not taken in the traps and only occasional bivalves, *Alasmidonta calceolus* and *Sphaerium* sp., have been collected from them.

SHORT NOTES ON FRESHWATER SNAILS

Artesian Wells. . . . If you live near an artesian well that isn't capped you might have some fun. Place a bag of wire window screen over the outlet and leave it for a few days. You may find that it will catch some strange forms of freshwater snails, crustaceans, etc. Some snails found in this manner were found to be blind . . .—Frank Lyman

Don't Overlook the Snow Pools. No pool, however small, should be ignored because it appears too insignificant to contain molluscan life. The pools of quarries, fields, and waste areas as well as wayside runs and water courses of melted snows and rains of spring should be given careful attention and if the visit, which should be made soon after the disappearance of the snow, is unsuccessful, successive visits should continue until molluscan denizens appear or it can be determined that the pool is uninhabited. Certain species which inhabit these transitory waters have a life span of only one or two years and the greater portion of this is spent in hibernation in the damp earth of the bed of the pool or its deep mud during the summer months after the complete evaporation of its water. Then they suddenly reappear in the spring when the water has been warmed by the sun and warm rains and for a brief period swarm over the surface of the pool. Again, as the water evaporates, they disappear to be seen no more until the following spring or until heavy rains refill the depression sufficiently to permit a resurrectionary opportunity of a few hours.

A notably large *Gyraulus circumstriatus* Tryon was found in such a pool that had remained unnoticed, although only a few feet from the highway, through a number of springs. By the second week of June this pool had completely evaporated and no visible water appeared during the remainder of the year. Yet *Gyraulus* reappeared the following year. *Fossaria dalli* F. C. Baker, a rare shell in this region, was discovered in an abandoned meadow pool of seasonal origin not over 20 feet in diameter at the time of discovery. Two weeks later the pool was non-existent, having disappeared by evaporation and soil absorption.—Clifford L. Blakeslee, reprinted from *Mollusca of the Niagara Frontier Region.*

FRESH WATER MUSSELS

By Henry van der Schalie

Reprinted from 1941 Annual Report, American Malacological Union

Articles dealing with collecting and preparing fresh water mussels for a cabinet have appeared from time to time in the past. Among the most

informative contributors the following authors may be mentioned: Lewis (1866 and 1868), Wetherby (1882), Dall (1892), Call (1898), Walker (1902), Ortmann (1911), H. H. Smith (1912), and F. C. Baker (1921). Modern collectors follow more or less the general methods which were tried and proved adequate by their predecessors. In the following account a summary of the methods now generally accepted will be given and whenever possible suggestions will be made which might show improvement upon earlier techniques.

One of the first problems that confronts a collector is the selection of a suitable region in which to collect. In the United States we are fortunate because the Mississippi River and its major tributaries, the Tennessee, Cumberland, and others, offer unusual opportunities for those interested in collecting mussels. No other region in the world produces as many species of naiades as are found in drainages of the eastern half of the United States. With the many good roads and the ready use of the automobile, regions formerly quite inaccessible are now open to those who find pleasure in gathering specimens and contributing to malacology. The best collecting grounds are found in limestone regions, but there are large portions of drainages in non-calcareous areas which are much in need of careful survey work. It should also be emphasized that many productive streams are being contaminated by man so rapidly that there is an immediate necessity for collecting in some places. It is important that a fauna be known before radical changes are brought about.

Mussel collecting is usually most successful during periods when streams are low. In this respect gathering naiades differs from land shell collecting. Generally there are certain seasons within areas when optimum field conditions exist. In the Great Lakes region low water stages are found in streams between August and October, and occasionally similar dry periods occur in May. In Alabama and western Georgia the dry seasons often appear during these same periods. Along the southeast coast however, the hurricane season frequently brings torrential rains so that late spring is often the best time for collecting in the rivers there. In small tributaries these matters are naturally of least significance, but they are of greatest importance for work to be done in the larger rivers. Consequently, it is very essential for successful field work that one select a season within an area when the streams are at their lowest possible water level.

Mussels inhabit streams and lakes, but there are usually fewer species in lakes. With the exception of large lakes, such as Lake Erie, the number of species inhabiting a lake is directly proportional to the amount of stream influence in such a body. In other words, small land-locked lakes have fewer species than river-lakes. Rivers harbor many species, the number depending entirely on the physiographic province to which the drainage belongs. One may collect as many as 50 species of mussels from portions of certain streams in Tennessee, while similar bodies in Alabama and Michigan may yield only half that number.

In streams mussels are often found most abundant on shoals where they live imbedded in the gravel, sand, or mud of the bottom. There is

usually a moderate current of water flowing across such shoals. The presence of dead shells along shore will often give a clue to the proximity of a shoal where collecting may be best. Also, in many places, the muskrats, raccoons, and mink gather mussels for food. These animals leave piles of shells at their feeding grounds. Such accumulations are signs that a good mussel bed is close at hand in the stream. Not only should one search the stream for live specimens but such shell accumulations as are left by muskrats are important sources for series of good specimens. Experience in collecting at kitchen middens of muskrats shows that those animals do not usually gather large specimens so that one should search in the stream for some of the larger naiades. Also, the thin-shelled forms, such as *Anodonta* and *Anodontoides,* are often broken by the teeth of the mammal. In any event, the muskrats are usually good collectors and one may find species in their refuse piles that are not easily found when working on the shoal in the river.

Many methods are employed in gathering mussels. Perhaps the oldest and certainly one of the best is gathering them by simple hand picking. Mussels are very sensitive to pollution and silting so that usually they are common and readily seen in streams where the bottom is easily visible. At first it will take a little practice to see a specimen because the animal imbeds itself deeply in the shoal and often only the posterior siphons are visible. One soon learns to look for the little double-holed slit that appears on the bottom. This slit represents the siphonal openings through which the animal breathes and gets its planktonic food. It at once becomes obvious that ripples on the water due to wind or current as well as a lack of sunshine—factors that hinder visibility—at times makes it almost impossible actually to see specimens studded in the bottom of a stream. On this account it is often advisable to carry a small rake with which to rake over the gravel and sand of the bottom. In such an operation it is usually best to move in an upstream direction as one collects on shoals. The current will then carry away any suspended matter caused by raking and the shells which have been uncovered can then be readily seen. Raking uncovers many small specimens which might otherwise be overlooked. The use of a small hand sieve is also recommended because by sifting samples taken from the bottom at various places on the shoal very young specimens showing details of beak sculpture are more readily available. Such minute forms are best preserved in vials containing 70 percent alcohol. To overcome poor visibility in recovering small shells from the bottom, a glass-bottomed bucket is often indispensable. There are some refinements of this aid in overcoming the bad effects of ripples, reflections, etc. but the glass-bottomed bucket is simple to make and quite efficient.

Where shoals occur in deep water it is often necessary to use a small hand dredge or a set of tongs. Such equipment, although very desirable, is often cumbersome to carry and may be omitted from the list of equipment actually necessary to one with only a general interest. There are, of course, regions where dredges or tongs are entirely indispensable. A few years ago while surveying the Ogeechee River in Georgia it was found that the lower

portion of that river was so deep and the water so colored that one had to rely entirely on a dredge operated from a boat to obtain an adequate series of mussels.

Another comparatively recent addition to the equipment of collectors is the diving helmet. There are a variety of these, but fundamentally they work on the same principle. Such helmets simply permit one to work at 10 or 15 foot depths to great advantage. This apparatus was recently used in the Grand River of Michigan where clammers managed to clean out thoroughly pockets of shells not accessible to the craw-foot bars and similar equipment in use on that river. Essentially the diving helmet is merely an aid for the hand-picking method of collecting.

When specimens are gathered it is necessary to have a container in which to place them. Various receptacles are used ranging from a basket to bags or sacks. In our work we have found that home-made sacks of about a half bushel or bushel capacity were very convenient. It is always well to have a large sack because often one gets into a productive territory when small ones prevent the taking of adequate series.

After a sufficient number of specimens have been gathered it is advisable to go to a comfortable place along the shore where notes should be taken about the collection. The most essential features in the note-taking would include concise information giving: date and numbers of collection, name of body of water, distance and direction from nearest town, the county, and the state. It is well to add such ecological data as would aid in recognizing a similar environment at some future date. The amount and nature of the notes taken is entirely dependent upon the interest and aspirations of the collector. However, it is most important that at the time the locality data are written into the notebook one or more locality labels be inserted into the sack or sacks containing the mussels. Without adequate locality data specimens are virtually worthless. Consequently, one cannot over-emphasize the importance of accurate labels. Data should be written in pencil on a good grade of label paper. Remember that mussels are often dirty and wet so that an inferior label will soon become soaked and disintegrate leaving the collector with a serious problem of interpretation at some later time. If one does not plan to clean the specimens until a day or two later it is often well to place a small, numbered metal tag in the sack at the same time tabulating that number in the field notebook. Unless the shells are cleaned at once the top of the sack should be securely tied with string so as to prevent any mixing of lots while one is traveling from one station to another.

When collecting it is well to take large series if they are available. This is valuable not only because it gives a better appreciation of the range of variation of characters within species, but also because a locality which one year produces an abundance of shells may be quite depleted at some later time. Often one finds it difficult to be certain in the field whether a specimen is one common at the station or one not hitherto found. For that reason it is safer to take good series so as to be able to distinguish more carefully when the time for cleaning the specimen arrives.

On a regular collecting trip it often saves time to accumulate mussels for 2 or 3 days. In that way one can utilize good weather conditions to the best advantage. After several large lots have accumulated it is advantageous to stop at a suitable place for cleaning and labeling the specimens. The animals are most conveniently removed from the shells by boiling. One starts a fire or uses a camp cooker to bring a pail of water to the boiling point. While the water is heating the contents of a sack are spilled on an open newspaper. The mussels are then sorted roughly into a reasonable batch according to the size of the specimens. Large shells should be boiled longer before the adductor muscles relax. It is often most convenient to place the mussels to be boiled in a sack and then the sack containing those specimens is deposited in the boiling water. They should remain immersed until one observes that most of the valves are gaping. The batch is then removed and placed on another clean paper to drain and cool sufficiently so that the animals might be conveniently removed. Should one wish certain specimens for alcoholics it is best to select those before the lot is boiled because in the boiling process the specimens shrink badly and are not suitable for anatomical work. One should also be cautioned against too vigorous boiling should one wish to save pearls which are at times found imbedded in the mantle when the animals are being removed. Boiling water may destroy the quality of a pearl.

By experience it has been found advantageous to nest the shells of large lots just boiled and from which the animals have been removed. The process consists of simply placing larger shells on the outside with smaller ones nestled within the larger . Small sets are thus made, allowed to dry for a short time, and then each batch is wrapped in a piece of newspaper with an identifying label. These small packages are tied with string so as to keep label and specimens together. The small bundles thus made are then placed into a nail keg putting the heavier parcels in the bottom and the small ones towards the top. Crushed newspaper is placed across the top of the keg, a piece of burlap bag is stretched over this paper, the hoop is nailed in place, a label is written and placed on the container, and the keg thus prepared is sent to its destination. Many such kegs have been sent by Mr. Clench and others who use this method and where the specimens are packed tightly one seldom finds even a single broken specimen. At the nearest railroad station one can freight or express the kegs and thus avoid hazards which attend carrying accumulations of mussels throughout a trip.

At times only a few mussels are found at a station. It is a waste of time to prepare a pail of boiling water for small series. These can best be cleaned by the use of a thin-bladed pocket knife. If one uses a thick-bladed knife the delicate edges of shells are often broken when the knife is inserted in the central margin of the shell in the effort to cut the adductors. Following the insertion of the knife one first cuts the anterior adductor muscle and then slits the posterior adductor. The elasticity of the hinge will automatically open the shell so that the animal can then easily be removed.

If one wishes to have the valves of a recently cleaned specimen stay together with the hinge remaining intact it is advisable to tie the valves

shut. This was formerly considered the proper way to prepare specimens and has some advantages. However, for a study of the mussels it is often an advantage simply to allow the hinge to dry in the relaxed or open position breaking the hinge later when the shells are placed into trays.

Washing specimens can best be done when one gets back from a trip. One lot, which constitutes all the specimens from one locality, should be cleaned at a time. Most shells can readily be cleaned by the use of a stiff brush, scrubbing the valves under running water. There are, however, specimens that cannot be cleaned that way, particularly shells with iron oxide deposits and other incrustations that accumulate on shells of certain regions of this country. As a rule, specimens badly coated with such deposits clean more easily if placed in a solution of oxalic acid. The solution is made readily by adding a few oxalic acid crystals to some water in a pan. The disadvantage of this treatment is that a little of the nacre on the inside of the shell is often slightly broken down during the period when the incrustations on the outside are being dissolved and loosened. To clean the inside of the shell of the chalk one may apply a little dilute hydrochloric acid with an old pair of forceps and a small swab of cotton. A thorough brushing and rinsing should immediately follow this treatment. The shells after being washed are placed on a drying rack in cardboard trays.

Cleaning mussels has its rewards. One certainly finds far more character for identification among cleaned specimens as opposed to those coated with incrustations. In the past, specimens were subjected to a great variety of treatments in order to improve their appearance. Most practices of this kind are unnecessary and in some instances the shells certainly lose their natural appearance, particularly in cases where varnish is applied. Fats, grease and vaseline are recommended by some. If these are used very sparingly there is at times some small advantage in using them, but where they are applied too lavishly they make specimens obnoxious to handle and certainly do not greatly enhance their appearance.

Cracking among thin-shelled specimens such as *Anodonta*, and even among some of the heavier forms (such as *Lampsilis ventricosa* and *Lasmigona complanata*), has been a serious problem in some instances. Although several methods are in use to prevent splitting, the problem has not been entirely solved. Clench (1931) recommends dipping specimens in a solution of paraffin dissolved in xylol. The xylol evaporates leaving a thin film of paraffin. In some instances this has proven advantageous but there are specimens that continue to check in spite of the paraffin application. Dall (1892: 40) recommends a small amount of vaseline which is rubbed into the epidermis to prevent cracking. Although both paraffin and vaseline are recommended there are opportunities for improvement in this particular problem.

A list of essential equipment for field work with mussels would include the following items:

- Field notebook
- Old newspapers for packing
- Small rake
- Tennis shoes for wading
- Nail kegs
- Burlap to cover kegs
- Nails for sealing kegs
- Labels and tacks for labeling kegs
- Vials containing 70 percent alcohol
- Field labels
- Pencils
- String
- Forceps
- Thin-bladed knife
- Bucket for boiling specimens
- Glass-bottomed bucket
- Collecting sacks
- Alcohol (70 percent) for preserving

The following brief bibliography may assist those who are interested in the literature dealing with collecting fresh-water mussels:

SMITHSONIAN INSTITUTION, 1860. *A Circular with Reference to Collecting North American Shells.* Smiths. Misc. Coll., vol. 2: 1-4.

LEWIS, JAMES, 1866. *Instructions for Collecting Land and Fresh-Water Shells.* Smiths. Inst. Ann. Rept. for 1866: 389-94.

——, 1868. *Directions for Collecting Land and Fresh-Water Shells.* American Naturalist, vol. 2: 410-20.

WETHERBY, A. G., 1882. *Directions for Collecting and Preparing Land and Fresh-Water Shells.* Journal Cincinnati Soc. Nat. Hist., vol. 5: 44-51.

DALL, W. H., 1892. *Instructions for Collecting Mollusks, and Other Useful Hints for the Conchologist.* Bull. U. S. Nat. Mus., No. 39: 1-56.

CALL, R. E., 1900. *A Descriptive Illustrated Catalogue of the Mollusca of Indiana.* 24th Ann. Rept. Indiana Dept. Geol. and Nat. Resources for 1899 (1900): 342-44.

WALKER, BRYANT, 1902. *Hints on Collecting Land and Fresh Water Mollusca.* Journ. Applied Microsc. and Lab. Methods, vol. 5: 1854-61.

ORTMANN, A. E., 1911. *A Monograph of the Naiades of Pennsylvania.* Mem. Carnegie Mus., vol. 4: 281.

SMITH, H. H., 1912. *Directions for Collecting Mussel Shells.* Ala. Geol. Survey, Museum Paper No. 3: 9-12.

HARMER, S. F., 1918. *Instructions for Collectors No. 9 Soft Bodied and Other Invertebrate Animals.* British Museum of Natural History.

BAKER, F. C., 1921. *Preparing Collections of the Mollusca for Exhibition and Study.* Trans. Amer. Microsc. Soc., 40: 31-46.

CLENCH, W. J., 1931. *A Preventive for the Scaling of the Periostracum.* Nautilus, 45: 30-31.

LAND SHELL COLLECTING

By William J. Clench

Reprinted from 1941 Annual Report, American Malacological Union

Land shells may be found nearly everywhere that there is some sort of protective cover. Conditions, of course, vary a great deal and one must study those conditions that are the best for mollusks in any given locality. Experience, however, will prove to be the most important factor associated in the collecting of land shells.

A few general hints can be given that may possibly aid the beginner. Lowlands along streams and lakes are generally found to be excellent as long as the area is above the flood line. Shaded areas of ravines where there is ample ground moisture and leaf cover are apt to be very good. Land shells generally shun exposed situations that are excessively dry during portions of a season. A good line of reasoning is to attempt to visualize the seasonal conditions that any one locality must undergo during the year.

Under bark and along the edges of logs and fallen trees usually lead to good "pickins." Also under stones and rocks that are not deeply imbedded in the soil. We have also found fine collecting, particularly in the middle west, on the forest floor in heavy and well shaded deciduous forests. Pasture land, not only the open country but even where there is forest cover, usually is poor unless there are plenty of logs to investigate.

Mountainous country, when there are limestone ledges, is usually rich in land snails. This is especially true if there is ample shade and plenty of moss and dead leaves at the base of these ledges. During wet weather, however, the snails will crawl to a limited extent over the wet rocks.

An ample supply of vials and cloth bags should be carried in the field. Large shells can be placed in bags and, if at all numerous, should have a generous mixture of leaves and grass to prevent their fouling one another. Small shells should be placed in vials for safe keeping. All mollusks that are to be preserved for anatomical purposes should be drowned in water for 8 to 10 hours and then placed in 60 percent alcohol. If the radula alone is to be studied, any strength of alcohol can be used above 60 percent.

If the shells are to be cleaned for the cabinet, they may be boiled and then extracted with a hooked safety pin. Shells from $\frac{1}{4}$ to $\frac{1}{2}$ inch should be boiled $\frac{1}{2}$ minute and for 1 minute up to the size of $1\frac{1}{2}$ inches and larger.

Small land shells are best cleaned out (after boiling) by a strong force of water. The simplest procedure is to use an ear syringe, forcing the water into the aperture, the operation being carried out in a pan of water. For very small shells a capillary tube can be made readily out of a small piece of glass tubing and then attaching a rubber bulb.

Adequate data should be kept of all stations. The best method that we have found is to maintain a field note book with a continuous series of field numbers. Each station receives a number and under it is recorded the locality, as precise as possible, the date and the general conditions that best describe the locality. To this, of course, may be added a list of the species obtained. The shells themselves should be fully labeled with the number, locality, date, and collector. The field number will lead back to other data in the field book when needed.

On expeditions or trips away from home it is wise to double the field book entry by using carbon paper, the carbon copies to be mailed home. Field books have been lost!

The above instructions are only of a general nature, and plenty of exceptions will be found after a short field experience. This experience will vary as different types of country are investigated.

Specific information relative to regions or to methods used can be had from workers in our museums as well as from the many private collectors throughout the country.

Trapping Small Land Snails. The collection and culture of large numbers of the terrestrial snail, *Cionella lubrica,* were essential in the study of the life cycle of the trematode, *Dicrocoelium dendriticum.* The usual methods of collecting snails had to be supplemented by other procedures because of peculiarities of habitat and distribution of this species. Our first problem was to devise means of concentrating *C. lubrica* to reduce the labor of collecting.

Moist soil, almost constant shade, and a large quantity of dead canes appeared to favor the congregation of snails in thickets. They could be found readily, partly buried in soil, on dead canes, and under stones, boards, and wet papers. However, we found it tedious and time-consuming to collect *C. lubrica* in the open pasture without the use of collecting devices. Because of our success in concentrating snails in shaded areas with gunny sacks, we tried their use on the pasture.

The snail trap for collecting *C. lubrica* consisted of a wet gunny sack, folded 3 to 6 times, covered with 2 or more layers of rocks. Small rocks were used for the lower layer, and this was covered with one or 2 tiers of larger, flat rocks. Care was taken to see that they were not heavy enough to press the entire surface of the sack against the ground. This arrangement provided circulation of air, kept the heat of the sun from the fabric and lower rock layers, and shaded the sack completely. The soil beneath remained cool, and moisture was preserved for much longer periods than in uncovered areas.

Bait was unnecessary to attract *C. lubrica* to these traps; in fact, substances usually employed by collectors, such as oatmeal and bran, were found to have no appreciable influence in attracting these snails.

The traps were examined 2 to 4 times weekly. Specimens were found in the traps on the undersides of the sacks and in the debris and soil under them. When the humidity was high or following precipitation, specimens were recovered occasionally from the tops of the sacks and the covering rocks. As many as 26 specimens of *C. lubrica* were found in individual traps at one time. Other species frequently encountered were *Vallonia pulchella, Zonitoides nitidus, Discus cronkhitei, Pupilla muscorum,* and *Helicodiscus parallelus.* The slugs, *Deroceras reticulatum* and *Arion circumscriptus,* were attracted in large numbers. These collections were made in the vicinity of Cazenovia, Madison County, New York.—Wendell H. Krull and Cortland R. Mapes, abstracted from "Studies on the Biology of *Dicrocoelium dendriticum* (Rudolphi, 1819) Loos, 1899 (Trematoda: *Dicrocoeliidae*), Including its Relation to the Intermediate Host, *Cionella lubrica* (Müller)." Appeared in *The Cornell Veterinarian,* vol. XLI, No. 4, October, 1951

Killing and Preparing Liguus. Killing *Liguus* by the ordinary method, in boiling water, results in loss of color; the green lines become bronzy or dirty gray. To preserve the natural color care must be taken that no steam

or hot water comes in contact with the outside of the shell. Various methods of killing are used. An excellent way is to place the snails, aperture down, on a towel in a tin plate, and expose them in an oven at about 300° for about 5 to 7 minutes. Or the specimens may be placed, aperture up, on dry sand and heated in an oven until dead. They may also be killed in the freezing compartment of a refrigerator, and pulled when partially melted out; but this method requires 12 hours or more. Too much dry heat fades the pink tints. Washing, if required, should be in cool water.

Specimens taken during rainy weather contain a great amount of water. They may be kept in a dry place or left hanging in a netted sack for a few days before cleaning. Collectors in the field for several days sometimes make rolls of the specimens, one layer deep, in paper, labeling each bundle outside. They will live a long time thus, and may be transported or shipped home for cleaning. As soon as cleaned, the symbol for locality should be written within the outer lip, or on paper pushed into the aperture. Poorly localized material is almost useless, and localities supplied from memory have often led to serious error.—Pilsbry, *Land Mollusca of North America,* vol. 2, pt. 1, p. 52, Acad. Nat. Sci., Philadelphia.

Shells from Moss. In the Ottawa, Canada region, fine specimens of *Striatura, Vertigo, Zonitoides,* and *Planogyra* have been obtained by sifting dried moss. Not all samples of moss will contain shells: the samples should be collected from moist areas, such as the edges of swamps, but not from ground flooded in the spring. Moss from shade, under trees or at the base of cliffs, especially limestone cliffs, is likely to yield more shells than that from more exposed situations. Gather generous samples of the moss, enough to fill a 10-pound paper sack; tie the mouth of the sack securely and allow to dry for a few days. When the moss is dry, crumble it gently with the fingers and pass it through sieves of several mesh sizes, from coarse to fine. The shells may be picked out by hand or under a binocular microscope.

Shells from Dead Leaves. In light woods, especially hardwoods, watch for dead shells on the surface of the leaves on the forest floor. If shells are found, take a large sample of the dead leaves in large paper sacks. Allow the leaf samples to dry, as for moss samples above, and sift for shells. Many small, rare shells have been found by this method.

Shells from Stream Drift. From time to time, useful lists of shells from stream drift have been published in the Nautilus, e.g. vol. 47: 16-17. Collect the stream drift from places where some obstruction, a log, fence, stream bank, or roots, has caused it to accumulate. This is best done in large sacks, such as 10-pound grocery sacks. Allow the material to dry and sift it out as for moss, above. If records from such material are to be published, it should be clearly indicated that they are from stream drift as the shells recorded may have traveled far from their original habitat.

Quarries and Ledges. Some of our smaller, hardy snails, such as *Gastrocopta, Hawaiia, and Zonitoides,* live in large numbers in limestone quarries, under the loose blocks of rock. They are seldom seen crawling about except

in wet, dark weather. I have taken large series from such places in Ohio while on fossil collecting trips in rainy weather. Ledges of limestone, especially if they are partly covered with soil, are fruitful collecting grounds for snails. From the soil between two limestone ledges near Ottawa, I have collected large numbers of *Gastrocopta holzingeri,* a snail that is otherwise quite scarce in the area. Old quarries, overgrown with trees and shrubs, are among my favorite collecting spots in Ohio and I have no doubt that such situations elsewhere would be equally productive. AURELE LA ROCQUE

NON-MARINE PLEISTOCENE MOLLUSCA

By AURELE LA ROCQUE

Department of Geology, The Ohio State University

The glaciers that covered large parts of Canada and the northern United States several times in the last million years or so altered the surface of the land wherever they spread. At this time, called Pleistocene by geologists, deposits of fine, dust-like material, called loess, accumulated in areas unaffected by the glaciers. As the glaciers melted, they poured unusually large quantities of water into the river valleys and altered the drainage pattern of the land, even far away from the glaciers themselves. The land and freshwater mollusks that moved into the territory uncovered by the melting glaciers give some indication of the history of the earth during Pleistocene time. Careful collecting of Pleistocene Mollusca can be of great scientific interest, yet it can be done without much special geologic or biologic preparation.

Pleistocene Mollusca are found in deposits of marl, where they are probably commonest, loess, silts, and peaty material almost everywhere in North America. Methods of collecting vary all the way from picking up shells on the surface of a deposit, or taking haphazard samples of marl from an exposure, to careful and systematic study of a particular deposit, using all the resources of geologic and biologic techniques. The procedures described here will yield material that can be used for scientific study of a deposit. They can be varied according to the time and effort the collector is willing to devote to the work. Nevertheless, even grab samples have their uses, especially in relatively remote areas, and the collector should not give up the idea of collecting Pleistocene Mollusca because he has neither the time nor the inclination to do the collecting in thorough fashion.

In collecting, the first question is how much to collect. In some samples, a handful of material will contain hundreds of shells, in others, only a few. The first rule is to concentrate on getting a sample of the material with shells, not on picking up individual shells on the surface. The second question is how to pack the sample. Plastic bags, such as those used for vegetables in grocery stores have been most satisfactory in the work done by the writer and his students as they retain the moisture of the sample collected. Some marls dry out as hard as rock if they are not washed and sieved immediately after collecting and the shells are then very hard to

separate from the marl. We have even added water to the sample in the plastic bag so as to ensure that it would remain wet until it was washed.

Thorough sampling of a deposit involves collecting from a measured section. In a deposit several feet thick, this means finding a place where the deposit has been cut or sliced through by a drainage ditch, road cut, or excavation and taking out a series of layers of the material, each layer 1 foot by 1 foot by 2 inches thick. It also means labeling the material from each layer and placing it in a separate plastic bag as it comes out of the cut. Likewise, the nature and appearance of each layer should be recorded in a field note book for later reference. Once the sample is collected, it may either be worked up by the collector or turned over to a specialist for sorting, identification, and interpretation. The latter means that the collector misses half the fun and profit from his work, so he is strongly urged to go on to the next two steps which can be easily learned, with some help from a specialist.

Each sample should be thoroughly soaked in water, overnight or even longer. If the material sticks together and to the shells, the sample should be boiled for a while in water; the movement of the boiling water helps to break up some samples. To separate shells from marl and silts, we have tried all of the following: boiling in water, with and without detergents; agitating in a Ro-Tap machine which shakes the sample through a series of sieves; and exposing the sample to water running through a shower nozzle. Some samples break up as soon as they are soaked in water; others have resisted all treatment and have been sieved, the next step in the process, with various amounts of mud and peat still sticking to the shells.

The next step is to run the sample through a series of sieves of various mesh sizes so as to get rid of the mud and retain the shells. For this, we prefer large sieves, 8 or 10 inches in diameter, but smaller sieves will do. We have used all sorts of combinations of mesh sizes to ensure retaining the smallest of the land and freshwater snails and ostracodes which are abundant in some lake deposits.

Next, the samples should be dried by being spread out on several layers of newspapers and left in open air at least overnight. Twelve to 18 hours is enough in heated buildings in winter or on a dry day in summer but a longer time may be required during hot, damp spells in summer.

Once the samples are dry, they can be boxed, labeled and stored for later study. For this we have used ice cream or cottage cheese cardboard containers of 1 pint and half pint capacity, but any kind of container that will hold such quantities of material will do. The problem is to get enough containers to hold a multitude of samples. If the samples are small, a quarter cup or so, empty flip-top cigarette boxes can be used, but quantities of them must be saved over a period of time to ensure a sufficient supply. Our smoker friends have come to the rescue here and supplied us with literally thousands of empty cigarette boxes over the years; we use them to store both unsorted samples and identified specimens.

No description of sorting processes need be given here as shell collectors

have devised numerous ingenious ones. We use a set of 10 to 20 small artist's color pans, round, 2 inches in diameter, to hold the kinds of shells sorted from our samples; we do the sorting in a Petri dish, a glass dish 4 inches in diameter in which the shells can be separated from the debris with brushes. We pick up the larger shells with tweezers and the smaller ones with fine brushes moistened as needed.

The next two steps are not strictly collecting and as such should not be described at length in an article on collecting, but they may be mentioned briefly here as they give the collector the fullest benefit from his collecting. Once the species are identified they provide a record of their history in the particular deposit studied. This may show that some species came in earlier than others; that other species died out before the end of deposition in the lake or pond studied; and that still others were very scarce at first and more abundant in the upper layers. These variations have their significance in interpreting the change of conditions within the area and around it. For example, many lake deposits contain land snails, washed in from the surrounding areas by streams. Their relative abundance in each stage of the lake, represented by the successive slices of material from the muds of the lake bottom, give interesting information on the development of the land area surrounding the lake. Examples of the information acquired in this way are given in papers by the writer (La Rocque, 1952) and Reynolds (1959).

Identification of inland Pleistocene Mollusca presents some difficulties but some references can be used to advantage. A few are listed below. For example, Pilsbry's monograph (Pilsbry, 1939-1948) can be used for land snails and F. C. Baker's (1928) paper on Wisconsin Mollusca and his later publications for freshwater forms, although the nomenclature in the former needs considerable revision. Correspondence with a specialist will clear up many points and the writer will be glad to offer what help and advice he can give to those interested.

REFERENCES CITED

BAKER, FRANK C., 1928. *The Fresh Water Mollusca of Wisconsin.* Wis. Geol. and Nat. Hist. Survey, Bull. 70, pt. I, 494 pp., pt. 2, 482 pp., 105 pls.

LA ROCQUE, A., 1952. *Molluscan Faunas of the Orleton Mastodon Site, Madison County, Ohio.* Ohio Jour. Sci., vol. 52, pp. 10-27.

PILSBRY, HENRY A., 1939-1948. *Land Mollusca of North America (North of Mexico)*, 2 vols., 994 and 1113 pp., illus.

REYNOLDS, MARTIN B., 1959. *Pleistocene Molluscan Faunas of the Humboldt Deposit, Ross County, Ohio.* Ohio Jour. Sci., vol. 59, pp. 152-166, 6 figs.

COLLECTING MOLLUSKS IN DESERT REGIONS

By Ernest J. Roscoe

Chicago Natural History Museum, Chicago 5, Illinois

Introduction. Success in collecting mollusks in desert regions depends largely upon (1) a knowledge of the desert environment and (2) a familiarity with the ecological requirements of these animals. This is true of collecting in any environmental type, of course, but is especially applicable

to desert areas where the paucity of favorable molluscan habitats makes the casual, hit and miss type of search often result in total failure, whereas the same technique in more humid regions usually results in a representative sample of at least the more common forms.

Desert collecting involves no paraphernalia or techniques not used in other regions. Since these matters have been covered elsewhere in this booklet, the remarks below are directed to the two points mentioned above.

The Desert Environment. The major area of North American desert is located in the western part of the continent, extending from southeastern Oregon and southern Idaho southward into Mexico as far as the Yaqui River, including most of the peninsula of Lower California. The continuity of this desert region is interrupted, of course, by the highlands of Utah, Arizona, and New Mexico. Within the broad area outlined above 4 distinct desert regions are recognized, the Great Basin, Mojave, Sonoran, and Chihuahan. Each of these desert regions differs from the others in details of climate, physiography, flora, and fauna. This paper was written with the Great Basin desert in mind, but it may apply, at least in a general way, to other areas as well.

The chief characteristics of a desert climate are: high temperatures with extreme daily and monthly ranges; low, infrequently distributed rainfall; low humidity; high evaporation; and a high percentage of cloudless days with high light intensity.

Physiographically the Great Basin consists of isolated, roughly parallel mountain ranges separated by nearly level basins or intermountain plains. Some undrained basins contain playa, or alkali, flats, with fine-textured soils, most of them with high concentrations of salts. The lower slopes of the mountains are covered by alluvial fans of coarse to fine materials.

A characteristic plant association has become adapted to this general environmental situation. It exhibits certain common features, notably in the adaptation of roots, stems, and leaves to withstand drought; the wide spacing of individual plants; slow growth; adaptation of life cycles to periods of abundant moisture; adaptations to high salt concentrations in some situations; and adaptations to the textural variations of the soil.

Ecological Requirements of Mollusks. The absence of a given kind of organism from a region does not necessarily imply that it could not exist there. Its absence may be due to insufficient means of dispersal, barriers that prevent it from reaching the area, or merely insufficient time to do so. Consideration of these topics would involve delving into problems beyond the scope of this paper.

In general, the most important problem for mollusks is desiccation, stemming from the fact that their soft bodies, devoid of impervious outer covering, must be kept moist at all times. Other things being equal, permanent bodies of water provide the most favorable habitats. Most mollusks are aquatic and have solved the moisture problem, but for terrestrial forms

or those living in temporary bodies of water the problem of desiccation is paramount.

The desert environment is not a particularly favorable one for molluscan life. One who has searched for desert mollusks is not so much impressed by their paucity as by the fact that they occur there at all.

The problem of desiccation is met by mechanisms that involve both diurnal and seasonal behavior patterns. A knowledge of these patterns will materially aid the collector. For example, pulmonate land snails are normally active on the surface of the ground only during the early morning and evening hours. During the warmer, drier portions of the day they retreat to the lower layers of the litter or under logs and rocks where the microclimate is more favorable. However, during stormy periods when the humidity is high these snails may be found actively crawling over the surface regardless of the time of day.

During the extremely dry, hot periods of mid-summer these land snails live in a temporary state of suspended animation termed aestivation. They retract into their shell, frequently attaching themselves to a leaf or twig to seal off the aperture. One or more membranous partitions (epiphragms) may be formed between the animal and the aperture. In some species the epiphragm may be so heavily impregnated with calcium carbonate that it resembles somewhat the operculum of the prosobranchiate snails.

Aquatic gastropods inhabiting temporary pools or intermittent streams may survive periods in which the bed is dry by burrowing below the surface into soil which retains some moisture. Aestivating *Planorbis* and *Lymnaea* have been kept alive under laboratory conditions for more than 2 years, and it is well established that some land snails are able to survive for long periods, up to 6 years at least, in a state of suspended animation.

The low temperatures of winter are avoided by a behavior pattern (hibernation) similar to aestivation. The chief difference between the two is that hibernation is more pronounced, the snails crawling to the lowermost levels of the litter and sometimes even burrowing for some distance into the ground before constructing the epiphragms.

Salinity and alkalinity are other problems with which mollusks of desert areas must cope, especially the aquatic forms. The collector will find that not all of the relatively few aquatic habitats are occupied by mollusks, presumably because of these problems. It is known that a variety of gastropods inhabited the fresh waters of Pleistocene Lake Bonneville, but as it receded and became saline the snails finally disappeared. No mollusks live in its remnant, the Great Salt Lake, at the present time. Our knowledge of the present aquatic gastropod fauna of the Bonneville Basin tends to indicate that the prosobranchs have a slight advantage in the more arid portions of this region.

Finally, it should be remembered that mollusks, like all other organisms, vary from kind to kind in their ability to resist unfavorable environmental conditions. The molluscan fauna of desert regions consists, therefore,

mainly of forms with a wide tolerance range for several environmental factors, notably temperature and moisture. It is only in the more favorable local areas, such as the higher elevations of desert mountain ranges, that other forms with more exacting requirements come into the picture.

FINDING SNAILS IN THE DESERT

By Wendell O. Gregg

My title may seem paradoxical since we think of snails as creatures requiring considerable moisture; and land snails, with which this paper deals principally, we associate with succulent gardens and humid forests. But live land snails are to be found in the desert, and in some instances without going to remote areas.

An example of an easy-to-collect desert snail is *Micrarionta bakerensis* Pilsbry and Lowe. It is to be found in fair abundance but a few yards from Highway 91, the main route to Las Vegas. The exact spot is on the east slope of a range of limestone hills about ½ mile west of Baker, in the Mojave Desert. In dry weather it may be found by digging deep in the rocks, but after a heavy rain the snails are near the surface, generally on the under side of surface rocks. A similar locality is the east slope of a hill south of Highway 66, just east of Newberry Springs where *Micrarionta unifasciata* Willett is found. In the vicinity of Palm Springs on the Colorado Desert there are 6 or 7 distinct forms, the type localities of which can be reached in a single day's collecting trip.

When traveling through the desert on a collecting trip, any rock slide seen should be suspected of harboring snails. *Micrarionta immaculata* Willett is found in such slides which are easily visible from the Vidal-Blythe highway about 7 miles south of Vidal, in Riverside County. Twenty recognized species and subspecies of *Micrarionta* live in our California deserts and another 4 on the Arizona side of the Colorado River. They are all to be found in rocky habitats. In our California deserts, 10 species and subspecies of *Sonorelix* are always found in rocky habitats with the one exception, *S. baileyi* (Bartsch) taken by Mr. Willett under dead agave plants, in addition to the usual rocky habitat. *Sonorelix* (*Herpeteros*) *angelus* Gregg was found by the writer under dead yuccas on the north slopes of the west ends of Soledad and Mint canyons.

Nine species of *Helminthoglypta* are true desert dwellers. *H. mohaveana* Berry is found near Victorville, on dry rocky hillsides, but is most abundant in a less arid habitat along the Mojave River where it is crossed by the Highway 91 bridge. On the hills almost directly across the river from this point *H. graniticola* Berry is to be found beneath rock piles or large flat rocks but in dry weather it burrows beneath the surface of the soil under the rocks. I have also found it buried among the roots of desert plants. *H. crotalina* Berry occurs in definite rock slides near the old Sidewinder Mine and *H. jaegeri* Berry on rocky hillsides in the Ord Mountains, near Sweetwater Spring. As indicated by the name, the type lot of *H.*

fontiphila Gregg was found where there was an abundance of moisture, north of the dam in Little Rock Creek Canyon, though this snail is related to the desert species of this genus. I was not surprised to find it later over more than 10 miles of arid, sage-covered hills to the east where it seeks shelter beneath dead yuccas. *H. isabella* Berry also occurs on hillsides beneath dead yuccas.

In southern California *Sonorella micrometalleus* (Berry) is found in extensive rockslides in a canyon 3½ miles south of the "Petrified Forest" in Kern County, or 1.7 miles north of the Red Hill-Handsburg highway. The Southern California molluscan subprovince includes a portion of western Arizona, as indicated by the presence of *Micrarionta* and the absence of those genera which characterize the Southwestern Molluscan Province.

Before leaving the subject of California deserts, we should not fail to mention Coachella Valley. Here a handful of sand, picked up at random, will contain from a dozen to a hundred tiny fossil snails, including from 2 to 6 species. These are freshwater snails that lived here when this area was covered by ancient Lake Cohuilla, at a time when there was abundant rainfall to feed this freshwater lake, which at one time covered an area of 2,200 square miles.

To the east is the Southwestern Molluscan Province which includes the greater part of Arizona and New Mexico and extends southward into Mexico and perhaps a small portion of western Texas. It is characterized by the presence of *Sonorella, Ashmunella, Oreohelix* of the subgenus *Radiocentrum*, and *Holospira*. Much of this province is typical desert, interrupted at intervals by mountain ranges. Snails of the genera *Sonorella* and *Ashmunella* are found from humid forests in the mountain ranges down to typical desert habitats in the foothills. Look for snails here in rocky hillsides and particularly in rockslides. *Holospira* is to be found on hillsides where limestone is present. At some times of the year it is out in the open, clinging to rocky surfaces, particularly on ledges of limestone. In places it lives under bear-grass and sotol. In dry, hot weather, it is generally found beneath rocks or desert vegetation.

We should not fail to mention the snails found in river drift. Flash floods caused by cloud-bursts in mountain and foothill country send torrents raging through the river channels. These torrents carry with them much organic debris, a large part of which is cast up at the stream's edge. The debris frequently contains numerous snail shells, most of them of tiny species, which have been brought down from hillsides and sometimes carried for a considerable distance. Dr. Pilsbry lists 34 species taken in drift along the San Pedro River near Benson, Arizona. We found 14 species here and many more from a locality along this river a few miles south of Benson.

Recent finds indicate that there are still undiscovered desert dwellers in this great area, passed by when the earlier collectors spent their time in the seemingly more promising locations in higher and more humid habitats.

PRESERVATION OF SLUGS

By LESLIE HUBRICHT

Reprinted from *The Nautilus,* Vol. 64, No. 3, January, 1951

The old method of killing slugs by drowning in a container filled with water is unsatisfactory because the slugs struggle and secrete large quantities of slime. The resultant specimens are not fully expanded and slime obscures the color pattern.

In the genus *Philomycus* there are a number of apparently distinct color patterns which seem to have definite geographical ranges. But when specimens are preserved these patterns are obscured by contraction and slime so that their distinctness is lost. I realized that if the genus *Philomycus* was to be understood, a better method of preservation would have to be found. After trying a number of methods I found that the following procedure would produce satisfactory results.

Fill a tight container with water and add enough Chloretone to insure a saturated solution and let stand for several days to dissolve. When killing slugs some of this solution is poured off into a jar and enough water added to cut the strength to 5 to 10 percent. It is not necessary to fill the jar as the slugs will not struggle or climb out, but in a few minutes become relaxed and extend themselves. Killing requires from 3 to 10 hours depending on temperature. When they are dead, which can be tested by pinching the tentacles with a pair of forceps, if there is no reaction they are ready for fixing. For fixing add enough 40 percent formaldehyde to make a solution of one part of the formaldehyde to 16 parts of water and leave for from 24 to 48 hours. After fixing they should be removed to 74 percent alcohol for preservation.

When this method is used the slugs are preserved life size with the color patterns clear, and there is no fermentation of the stomach contents which sometimes happens with the old method. Although the killing is hastened by warmth, care should be taken to prevent overheating. The heat produced by parking a car in the sun will ruin the specimens if they are left inside. Wrapping the jar in a wet towel and placing it where the air can get to it will prevent loss of specimens in warm weather.

When to Collect Slugs. My best collections of slugs have been made in rainy weather. I remember collecting large suites of *Philomycus* from tree trunks, as far up as 5 feet from the ground, in Quebec hardwood forests. On a geological field trip during which we were caught in a steady rain, I have seen *Philomycus* crawling about on wet, bare rock in a situation which I would have thought most unfavorable for them. This was an exposure of Black Hand conglomerate, containing little calcium carbonate, and with no vegetation cover whatsoever. The slugs were numerous, about one to every square yard, and I presume that they took refuge in the cracks of the rock during dry weather. Had I not seen this locality in the rain, I would never have suspected that slugs were present. I therefore heartily

recommend collecting in the rain, in spite of the discomfort it entails.—
AURELE LA ROCQUE

☆

Nature Provides Aid to Shell Collectors. It is by no means difficult to collect big shells, once the collector has learned where to look for them. However, for the smaller and smallest ones, it is a different matter, and it often takes hours to locate one or two specimens of snail shells of, say, $\frac{1}{16}$ inch in length.

Fortunately, nature has provided an easier way that produces better results. Various animals of medium size, both in fresh water and the ocean, have developed a keen interest in tiny shells, though for reasons quite different from the human collector's. For instance, the larvae of some caddis flies use minute fresh-water shells, snails as well as clams, to cover their cases. Thus the collector will find all the small species of shells that live together with these caddis flies represented on their cases.

On the seashore, especially in warm and tropical regions where the beaches are covered with coralline growth and this growth is covered again with sessile animals and sea plants that offer ideal hiding places, it is almost impossible to look for individual minute shells. In this situation bigger animals, such as starfish, sea-cucumbers, and sea-slugs, feed upon smaller animal life and, among it, on very little shells. By opening the stomachs of these animals of prey, the collector will find, with far less effort and in far shorter time than if he had to rely on his own resources, numbers of the very tiniest shells that often contain animals still alive.—
FRITZ HAAS, *Chicago Natural History Bulletin, June, 1953*

". . . But one day when you are out without your fancy collecting equipment and find something worthwhile, remember that a finger and a thumb make a quite good substitute for weak-spring tweezers, while a shirt pocket can double for a vial or carton until you get your treasure home!"—
FRITZ HAAS

ARRANGEMENT AND STUDY OF SHELL COLLECTIONS

THE SHELL COLLECTION

By R. Tucker Abbott

Reprinted from *American Seashells*

Although seashells are easy to keep since they do not deteriorate and generally do not fade in color like many insects, they present many special problems in housing because of their many sizes and shapes. There are three general types of collections — the knick-knack shelf, the display arrangement, and the study collection.

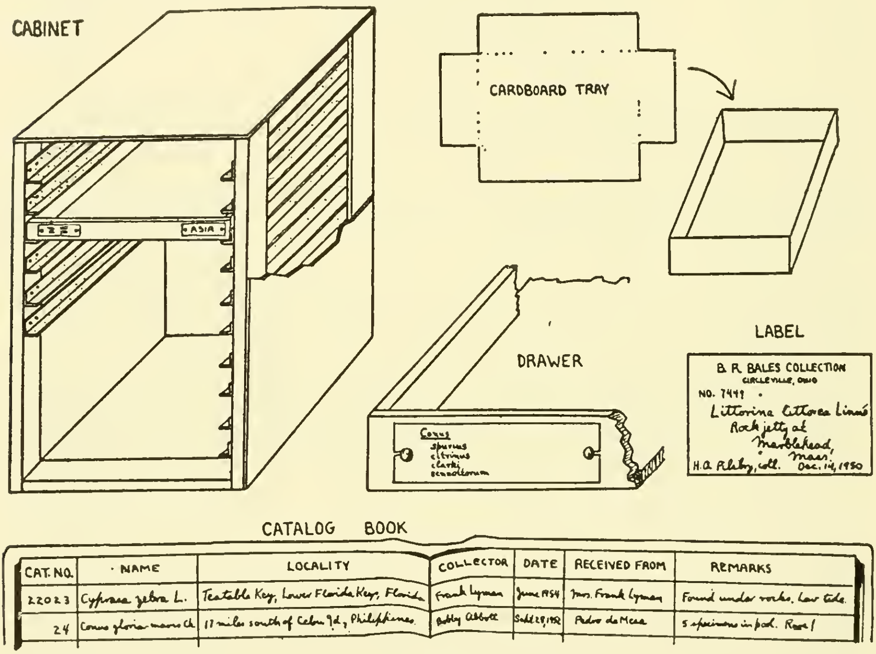
The first of these is usually the result of a summer's random beach collecting by the novice or a living-room auxiliary to the main collection. Many important private collections have started in this manner.

The display collection for museums, libraries, clubs or even the home is limited by the pocketbook and by the type of secondhand display cabinets that can be afforded. Little more is needed than common sense attention to matters of good artificial lighting, attractive but neutral background, neat labeling, choice of specimens and especially the avoidance of overcrowding. The exhibit should be designed for its eye-appeal as well as for its interest. One has a wide choice of themes—a selection of local shells, mollusks of economic or medical interest, shells of odd habits, examples of colors and patterns and a host of others. The labels of exhibits showing classification should bear the scientific and common names and the geographical range. Miniature display boxes with cotton background and glass or cellophane covering are very popular and, if of uniform size, may be neatly stacked in a closet when not in use.

The name "study collection" may sound ominous to some but, if a few simple principles are followed, this type of housing will bring more joy and less work than any other system. It is not only neater, more compact and equally as attractive as the display type, but it also permits the collector to locate any specimen quickly and add new material with a minimum of rearranging. The simplicity, uniformity, and mobility of equipment, such as drawers, trays, labels, and vials, and the use of the biological or systematic order of arrangement are the essence of a good collection.

The choice of cabinet and style of drawers will be limited, of course, by the collector's pocketbook. The accompanying designs (Fig. 1) are the result of many years of observing private and institutional cabinets, and they are offered here as an ideal towards which you can strive.

If the cabinet is made in a roughly oblong shape and is about table-height, additional cabinets may some day be set alongside for desk space or set on top of each other without causing the top drawers to be too high to reach. Pine, basswood or any of the whitewoods may be used. It has been reported that certain oaks have a detrimental effect on shells which have been stored away for years. It is best to have a cabinet door which swings open all the way (180 degrees), although so hinged that the drawers may still be pulled out when it is open only 90 degrees. Some students prefer the type of door which lifts off.



The shell collection.

The ideal cabinet has the following dimensions: outside measurements, height 40 (or 80), width 22, depth 32 inches. Runners for drawers, 30 inches long. If wooden, $\frac{1}{2}$ x $\frac{3}{8}$ inch and set $2\frac{1}{4}$ inches apart. If galvanized sheet iron, $2\frac{1}{2}$ inches wide and bent along the midline to form an L. Inside measurements, wooden drawers 20 x 30 x $1\frac{5}{8}$ inches. No runners or handles are necessary on the drawers.

All cardboard trays to hold specimens should be $\frac{3}{4}$ inch in depth, and all their other outside dimensions should be multiples of the smallest type of tray. This unit may be $1\frac{1}{2}$ x 2 inches, the next largest 3 x 2, then 3 x 4, then $4\frac{1}{2}$ x 6, and the largest of all 8 x 9 inches. It is inadvisable to have

more than 5 sizes of trays, since this complicates curating and the making or ordering of future stocks. Odd-sized trays make a neat arrangement impossible. Cardboard trays covered with glossy-white enameled paper may be purchased in any large city, or a simple style may be made by cutting out and folding pieces of shirtboard as shown in our illustration. The corners are held together by adhesive paper or butcher's tape. The various sets, or lots as they are called, of each species should be placed in the trays and arranged in the drawer from left to right, beginning at the front. Many students separate the species or genera by turning over an empty box which may bear a label indicating the genus or species.

Small glass vials without necks are used to hold smaller specimens. Cotton is best for plugging the vials, since corks are expensive, are difficult to obtain for various-sized vials and eventually deteriorate. When a lot consists of 100 or more small specimens which will not easily go into vials, it is convenient to use a covered box 3 x 4 inches and 2 inches deep. The label should be pasted on the lower left corner of the lid. A duplicate label or a slip of card bearing the catalog number should be placed in the box. Some people can afford to have glass-covered boxes.

A catalog is most essential, and its single purpose is to prevent the loss of valuable locality data. If each specimen bears the same number as the label and catalog entry, it can be returned to its proper tray in case of accidental spilling. A thick ledger about 12 x 8 inches may be purchased at a second-hand office equipment store at small expense. Headings may be arranged across both pages as shown in Figure 1. More space should be given to "Locality" than to any other section. Run your catalog numbers from 1 on up. Do not experiment with mystical letters indicating the locality, collector or date of cataloging, since all this information will be on your label and in your catalog. A card catalog arranged systematically is useless, time-consuming and a duplication of the information already available from your collection.

Specimens should be numbered in India ink with a fine pen. Shells that are too small to number may be put in vials or covered boxes, but do not fail to add a small slip bearing the catalog number.

The housing of molluscan animals, octopus and other soft-bodied creatures which must be preserved in 70 percent grain alcohol is expensive and generally beyond the scope of the average private collector. It may be mentioned, however, that preserving jars with rubber rings and clip-on glass lids are best. Vials with necks may be plugged tightly with cotton and set upside down in the jars.

The mollusk collection should be arranged systematically, that is, in biological sequence, with the first drawer containing the primitive abalones, followed by the limpets and on up to the specialized bubble shells (*Bulla*). The small chiton, cephalopod, and scaphopod classes may be put at the beginning of the gastropods or between them and the bivalves. You may wish to place your unsorted or unidentified material in the last few drawers. Once you have a species represented in your collection, do not stop there.

Add other lots from other collecting regions. You will then learn to appreciate individual, ecological, and geographical variations.

Exchanging. An amazing amount of traffic of duplicate material exists throughout the country and in many parts of the world today. Exchanging is an ideal way of sharing your local rich hauls and of obtaining species beyond your collecting sphere. A list of the many hundreds interested in exchanging is published in several directories of conchologists and naturalists. Sound out your prospective exchanger to learn what species or type of material he desires, since advanced collectors are extremely "choosy." Always give accurate locality data and send as perfect specimens as you can. Some people make up elaborate exchange lists which they send around to other collectors. Exchanging, although worthwhile, is time-consuming, and great care must be taken that the upkeep of your main collection does not suffer.

Excellent specimens with largely reliable locality data may be obtained from a number of dealers. Their prices are often high, but this is justified, at least with regard to locally dredged material, by the high cost of operating boats and replacing dredges. Like antiques and costume jewelry, the prices of shells vary with what people will pay.

Shipping. When sending shells on exchange or to some other collector for identification, always include a fully inscribed label with each lot. Most shells are best protected by loose wrapping in old newspaper. Small or fragile shells should be boxed with cotton. Mail or express shipments up to 20 pounds will travel safely in cardboard cartons obtained from the grocery store. The top and bottom should be padded with 2 inches of crumpled newspaper. Small lots are conveniently sent in mailing tubes. It is inadvisable to send living snails through the mails, and foreign imports of living land and fresh water mollusks are prohibited by law except by prior permission from The Surgeon General, U. S. Public Health Service, or from The U. S. Department of Agriculture, Washington 25, D. C.

Identification Services. Besides popular books and a few professional papers available in public libraries, there are few places where amateurs may turn for expert determinations. Fortunately, not a few private collectors are even more familiar with their local faunas than are the professional workers. Although some charge fees for their services, most are only too happy to identify your "sticklers." It is customary to name only material which has been sorted and which has accurate and detailed locality data, and to send a sufficient series so that the identifier may retain a sample for his efforts. It is a breach of etiquette to send material before asking if the identifier is willing to undertake the task. Sending photographs is highly unreliable and is tantamount to saying that you do not trust the specimens out of your hands. Some museums will identify specimens if you are unable to do so after serious effort, and this, of course, can only be done if the curator or research worker has the time. Never send more than 5 species at a time. It is surprising how many people abuse this service, purely voluntary on the part of the expert, by sending unsorted, data-less

shells. It is more important that the professional spend his time in caring for his vast collections, doing his research and writing for the benefit of all, than in identifying for the few. Medical workers, agriculturalists, archaeologists, fisheries men, ecologists, and other professional malacologists already demand a great deal of his time.

BOOKS AND PERIODICALS USEFUL TO THE COLLECTOR

Based on the list prepared by the Division of Mollusks,
U. S. National Museum

DIRECTORIES AND U. S. JOURNALS

Directory of Conchologists; an American and international list of people interested in mollusks; names, addresses, interests and exchange activities. Write: Mr. John Q. Burch, 4206 Halldale Ave., Los Angeles, California. Mimeographed.

Annual Report of the American Malacologicdl Union; sent without charge to members. Contains abstracts of papers read at annual meetings, news of member clubs, names and addresses of over 500 members, revised annually. Write: Secretary, Buffalo Museum of Science, Buffalo 11, New York.

The Nautilus; a quarterly devoted to the interests of conchologists; technical and semi-popular articles, notes and news. Write: H. B. Baker, Business Manager, 11 Chelten Road, Havertown, Pa.

Minutes of the Conchological Club of Southern California; many valuable papers, notes, news of collections and collectors. Write: Mr. John Q. Burch, 4206 Halldale Ave., Los Angeles, California. Mimeographed.

BOOKS AND ARTICLES

General

Abbott, R. Tucker, 1955. *Introducing Seashells;* 64 pp., 6 large color plates, numerous drawings. How to build and keep a shell collection.

Allan, Joyce, 1956. *Cowry Shells of World Seas.* x + 170 pp., 15 pls. Georgian House, Melbourne, Australia.

Bartsch, Paul, 1931. *Mollusks;* Smithsonian Scientific Series, Vol. 10, Part III, pp. 251-357, 36 plates. Excellent review of the field.

Cooke, A. B., 1895. *Mollusca;* Vol. 3, *The Cambridge Natural History,* 459 pp., 311 figs., 3 maps. Popular and technical.

Hutchinson, William M., 1954. *A Child's Book of Sea Shells;* 30 pp., numerous black and white drawings. Excellent children's book (9-15 years).

Mayo, Eileen, 1944. *Shells and How They Live;* 33 pp., numerous paintings. Good child's book, same age level as the preceding.

Pelseneer, Paul, 1906. *Mollusca;* Vol. 5 of Ray Lankester's *A Treatise on Zoology,* 355 pp., 301 figs. Technical; excellent for advanced students.

Platt, Rutherford, 1949. *Shells Take You Over World Horizons;* 50 pp., 32 full colored plates. *National Geographic Magazine,* July, 1949.

Rogers, Julia E., 1951. *The Shell Book;* 485 pp., 87 plates (8 in color); excellent for beginners. Reprint of 1908 edition, names brought up to date by Harald A. Rehder.

Smith, Maxwell, 1940. *World-Wide Sea Shells;* 139 pp., many drawings.

Verrill, A. Hyatt, 1936. *Strange Sea Shells and their Stories;* 211 pp., text figs., 5 plates, 1 colored.

——, 1950. *The Shell Collector's Handbook;* 228 pp., illustrated.

Webb, Walter F., 1942. *United States Mollusca;* 220 pp., 63 plates; deals with marine, land, and freshwater shells. Useful and interesting.

——, 1948. *Handbook for Shell Collectors;* 236 pp., about 1,000 species figured.

——, 1948. *Foreign Land Shells;* 183 pp., 73 plates. Some freshwater shells included, and interesting stories.

Western Atlantic, Florida, West Indies — Marine

Abbott, R. Tucker, 1954. *American Seashells;* 541 pp., 40 plates (24 in color), many figures. All common and most rare North American species covered. Excellent.

——, 1958. *The Marine Mollusks of Grand Cayman Island, British West Indies;* Academy of Natural Sciences, Philadelphia, Monograph 11, 138 pp., 5 plates.

Aldrich, Bertha D. E. and Snyder, Ethel, 1936. *Florida Sea Shells;* 126 pp., 11 plates; about 150 species included.

Arnold, Augusta F., 1903. *The Sea Beach at Ebb-Tide;* 470 pp., 600 figures; section on mollusks included.

Clench, William J., *et al.,* 1942. *Johnsonia;* Monographs of the Marine Mollusca of the Western Atlantic. Vol. I, II, 300 pp. each; sold by subscription. Excellent figures, descriptions, ranges, collecting localities, book reviews, etc. Write: Dr. William J. Clench, Museum of Comparative Zoölogy, Cambridge 38, Mass.

Hall, F. W., 1946. *Shells of the Florida Coast;* 30 pp., 122 figures. Shell pamphlet for amateurs.

Johnson, Charles W., 1934. *List of Marine Mollusca of the Atlantic Coast from Labrador to Texas;* no illustrations or descriptions but excellent list. Good bibliography.

Morris, Percy A., 1939. *What Shell is That?* 198 pp., 175 plates. Pocket guide for collectors in eastern U. S.

——, 1951. *A Field Guide to the Shells of our Atlantic and Gulf Coasts;* 236 pp., 45 plates (8 in color). A good handbook.

Perry, Louise and Schwengel, Jeanne, 1955. *Marine Shells of the Southwest Coast of Florida;* 320 pp., 55 plates. Mostly shells of Sanibel Island, revised in 1955. Well illustrated, good descriptions; for amateurs and advanced students.

Richards, Horace G., 1938. *Animals of the Seashore;* 273 pp., 28 plates, 45 figures. Marine life of middle Atlantic states.

Smith, Egbert T., 1946. *Romance of Sea Shells;* 28 pp., 6 plates. Well illustrated pamphlet, Florida shells .

Smith, Maxwell, 1937. *East Coast Marine Shells.* 308 pp., illustrated.

Vilas, C. N. and Vilas, N. R., 1954. *Florida Marine Shells;* 146 pp., 12 plates in color. For amateurs. Revised.

Eastern Pacific, West Coast U.S.A., California — Marine

Abbott, R. Tucker, 1954. *American Seashells;* see under Western Atlantic.

Fitch, J. E., 1953. *Common Marine Bivalves of California;* 102 pp., 63 figures, Calif. Fish. Bull. No. 90. Excellent.

Grau, Gilbert, 1959. *Pectinidae of the Eastern Pacific;* Allan Hancock Expeditions, Vol. 23, 308 pp., 57 plates.

Hill, Howard R. and Thompkins, Pauline, 1954. *Common Sea Shells of the Los Angeles County Coast;* 48 pp., 107 figures. Useful to amateurs.

Keen, Myra, 1937. *An Abridged Check List and Bibliography of West North American Marine Mollusca;* 84 pp.; has an excellent and very useful bibliography.

——, 1958. *Sea Shells of Tropical West America;* 624 pp., 10 colored plates, text figures.

Keep, Josiah and Baily, J. L., Jr., 1935. *West Coast Shells;* 350 pp., 334 text figures. Very useful.

Morris, Percy A., 1952. *A Field Guide to the Shells of the Pacific Coast and Hawaii;* 220 pp., 40 plates (8 in color).

Oldroyd, Ida S., 1924-1927. *The Marine Shells of the West Coast of North America;* Vol. 1, Vol. 2, Pts. 1-3, 900 pp., 165 plates.

Ricketts, E. F. and Calvin, J., 1948. *Between Pacific Tides;* 365 pp., 46 plates, 129 figures.

Smith, Maxwell, 1944. *Panama Marine Shells;* 127 pp., illustrations. Revised edition.

Indo-Pacific, Japan, Australia — Marine

(See also under *General,* Rogers, Webb, Smith)

Abbott, R. Tucker, 1959. *Indo-Pacific Mollusca — Monographs on the Marine Mollusks of the Tropical Western Pacific and the Indian Oceans.* Vol. 1, No. 1, *Introduction* and *Family Vasidae.* First installment of a series.

Allan, Joyce, 1950. *Australian Shells;* 470 pp., 40 plates (12 in color); no author names after scientific names.

Barnard, K. H. *A Beginner's Guide to South African Shells;* 215 pp., 5 colored plates, many figures. For amateurs.

Cahn, A. R., 1949. *Pearl Culture in Japan;* 91 pp., figures. Leaflet No. 357, U. S. Fish and Wild-Life Service; excellent and comprehensive.

Cotton, B. C. and Godfrey, F. K., 1938-40. *The Molluscs of South Australia;* Pt. I and Pt. II, 600 pp., 589 figures. Pelecypoda, Scaphopoda, Cephalopoda, Crepipoda; (Gastropoda not yet published). Every species well illustrated.

Dell, R. K., 1956. *The Archibenthal Mollusca of New Zealand.* N. Z., Dominion Museum Bulletin, No. 18, 235 pp., 27 plates.

Edmondson, C. H., 1946. *Reef and Shore Fauna of Hawaii;* 381 pp., 223 figures, 100 pp., 75 figures on mollusks.

Hirase, S. and Taki, Isao, 1951. *A Handbook of Illustrated Shells from Japanese*

Islands and Their Adjacent Territories; 134 plates (130 in color); excellent for amateurs interested in Pacific shells.

Jutting, T. van Benthem and Bessem, Paul 1952. *"Gloria Maris" Shells of the Malaysian Seas;* 64 pp., 65 plates. An art book, excellent photographs.

Kaicher, Sally D., 1956. *Indo-Pacific Sea Shells.* First part 1956, 5 parts of 8 issued by 1957. Privately published.

Nichols, J. T. and Bartsch, Paul, 1945. *Fishes and Shells of the Pacific World;* Pt. III (shells), 73 pp., 16 plates. A general introductory survey.

Powell, A. W. B., 1946. *The Shellfish of New Zealand;* 106 pp., 26 plates (1 in color); check list and illustrations of common species.

——, 1957. *Shells of New Zealand;* 3rd ed., 202 pp., 36 pls., text figs. A new edition of the preceding under a slightly different title.

Tinker, S. W., 1952. *Pacific Sea Shells*; 238 pp., 106 figures; handbook of common marine mollusks of Hawaii and the South Seas.

——, 1958. The same; revised edition, 230 pp.

Verco, J., 1935. *Combing the Southern Seas;* 174 pp., 18 plates (3 in color); accounts of dredging and collecting.

Land and Freshwater Mollusks of North America

Baker, Frank C., 1928. *The Freshwater Mollusca of Wisconsin;* Pt. I (Gastropoda) 507 pp., 28 plates; Pt. II (Pelecypoda) 480 pp., 76 plates.

——, 1939. *Fieldbook of Illinois Land Snails;* 166 pp., numerous text figures. Excellent for beginners.

Goodrich, Calvin, 1932. *The Mollusca of Michigan;* Univ. Michigan, Univ. Museum, Mich. Handbook series, No. 5, 120 pp., 7 pls., text figs.

Pilsbry, Henry A., 1939-1948. *Land Mollusca of North America* (North of Mexico); Vol. I (2 pts.) 1003 pp., 580 figures; Vol. II (2 pts.) 1113 pp., 585 figures. The definitive work on the subject; technical, but useful to amateurs. Excellent.

Robertson, I. C. S. and Blakeslee, C. L., 1948. *The Mollusca of the Niagara Frontier Region;* 191 pp., 13 plates; how to collect, collecting sites, descriptions, references. Excellent.

Collecting, Cleaning, and Mounting Shells

Dall, W. H., 1892. *Instructions for Collecting Mollusks, and Other Useful Hints for the Conchologist;* 55 pp., out of print, available at libraries.

Light, S. F., 1954. *Intertidal Invertebrates of the Central California Coast;* revised; 446 pp.

Poirier, Henry, 1954. *An Up-to-date Systematic List of 3200 Seashells from Greenland to Texas, Translation and Gender of Their Names;* 215 pp., mimeographed.

Stephens, T. C., 1946-1947. *The Collection and Preparation of Shells;* Vol. 24, No. 9 and Vol. 25, No. 1 of *Turtox News;* 15 pp.; a rather full annotated list of references.

OUTSTANDING SHELL COLLECTIONS

By R. Tucker Abbott

Reprinted in part from *American Seashells*

There are a number of very lovely private collections in the United States, some devoted wholly to marine species, others limited to land or fresh-water types. Many represent years of collecting, others an expenditure of many thousands of dollars. To mention a few would be to slight many another. The best private collections are in California, Florida, Connecticut, the New York area, and Massachusetts. As time passes, private collections are either sold, lost or left to some public or university museum, so that today we find the largest collections housed by public or endowed institutions.

The United States National Museum, under the Smithsonian Institution in Washington, D. C. contains what is undoubtedly the largest mollusk

collection in the world. Until Dr. Paul Bartsch, now retired, was curator, it was second in size to that of the British Museum in London. Today, this study collection contains over 9,000,000 specimens, 600,000 lots or suites and is in the neighborhood of 36,000 species and subspecies. Its curator at the present time is Dr. Harald A. Rehder.

The Museum of Comparative Zoölogy at Harvard College, Cambridge, Massachusetts, has risen to second place in the United States within the last 15 years. It is famous for its well-kept collection of about 7,000,000 specimens, 300,000 lots of approximately 28,000 species and subspecies. Its present curator is Dr. William J. Clench, noted for his development of students in mollusks. Dr. Ruth D. Turner is assistant curator.

The Academy of Natural Sciences of Philadelphia, Pennsylvania, is third or fourth in size and contains an unusual amount of valuable material. Its present curator, the author, has been with the institution since 1954, succeeding Dr. Henry A. Pilsbry who occupied the post for over 60 years, during which he has contributed more to our science than any other worker. He was preceded by two equally famous curators, George W. Tryon and Thomas Say, America's first malacologist.

In the midwest, one of our largest fresh-water and land collections is located at the Museum of Zoology, University of Michigan, Ann Arbor. Dr. Henry van der Schalie, an expert on fresh-water clams, is the curator. The Chicago Museum of Natural History in Illinois contains a small but adequate collection and is under the care of Dr. Alan Solem who recently succeeded Dr. Fritz Haas, a scientist well-versed in many phases of malacology.

There are no very large study collections in the southeastern United States, although one of the finest exhibit collections is on display at Rollins College at Winter Park, Florida. It is well worth visiting, for the collection is beautifully lighted and arranged and is instructively labeled. Of equal brilliance, the Simon de Marco collection of rarities is housed in the commercial Florida Marine Museum near Fort Myers, Florida.

The following collections of marine mollusks are located on the Pacific Coast of the United States:

Department of Geology, California Academy of Sciences, Golden Gate Park, San Francisco. Large general collection, emphasis on Eastern Pacific; especially strong in Panamic fauna. Original collection destroyed by fire and earthquake of 1906. Major collections: Henry Hemphill (West American); Emmet Rixford (general); Mackenzie Gordon, Jr. (West American, especially California). Excellent library. Curator: Dr. G. D. Hanna; Associate Curator: Dr. L. G. Hertlein; Research Associate: A. G. Smith. Exhibits. Large collections of Mesozoic and Tertiary fossils.

Department of Geology, Stanford University, Stanford Station. Very large general collection, emphasis on Eastern Pacific. Major collections: I. S. Oldroyd (West American); Henry Hemphill collection of duplicates (West American); G. W. Taylor (general); E. K. Jordan (general); and Sarah Mitchell (Philippine). Excellent library. Curator: Dr. Myra Keen. Exhibits. Large collection of Mesozoic and Tertiary fossils.

Museum of Paleontology, University of California, Berkeley. Large general collection, emphasis on Eastern Pacific. Major collections: Legislative Purchase of 1884 (general); Warren Cheney (West American); Joseph Rowell (West American); D. O. Mills (general). Curator of Invertebrates: Dr. J. W. Durham; excellent library. Exhibits. Largest collection of Tertiary fossils on the coast; also Paleozoic and Mesozoic collections.

Museum of Natural History, Pacific Grove. Small collection of California mollusks. Curator: M. E. Hinshaw. Exhibits.

Natural History Museum, San Diego; maintained by the San Diego Society of Natural History. Very large general collection, especially strong in Panamic fauna. Major collections: H. N. Lowe (West American, especially Panamic fauna, Lowe Bequest of $25,000 for curation); Fred Baker (general, mostly Eastern and Western Pacific); A. M. Strong (West American, much sub-megascopic material); and J. F. Anderson (general). Curators: Mr. and Mrs. E. P. Chace; Research Associate: Dr. J. L. Baily, Jr. Library. Exhibits.

Allan Hancock Foundation, University of Southern California, Los Angeles. Large collection of Eastern Pacific material, especially strong in Panamic fauna; collection obtained in most part by dredging operations of the Velero III and IV. Bulk of collection preserved in alcohol. Curator: Dr. N. T. Mattox. Good library.

Los Angeles County Museum, Los Angeles. General collection, including some West American material in alcohol. Curator, Dr. H. R. Hill.

Department of Geology, University of California at Los Angeles. West American material, comprising the personal collection of the late George Willett. Curator: Takeo Susuki. Library. Mesozoic and Tertiary collections.

Cabrillo Museum, San Pedro. Maintained by Recreation Department. Exhibit of Pacific Coast fauna. Curator: John Olquin.

MECHANICS OF A SHELL CLUB

By Robert J. L. Wagner

Secretary, Philadelphia Shell Club

People want to "belong" and to be accepted by groups. They expect something from these groups (many never know just what) and they want to be entertained. This association must be reasonable in price, not too technical, in a location that is readily accessible, and at a time that does not interfere with other social obligations. How to meet these requirements is a constant challenge, especially so when organizing and conducting a successful shell club.

It must be realized that with the increased publicity concerning the things of the sea now being provided by books, television programs, newspaper articles, sale of shell kits and specimen shells by an ever-increasing number of dealers—because of these coupled with our magpie instinct to collect things, shell clubs should be on the increase. We must be prepared to cope with the situation attending the formation of such clubs. People are going to want more and more knowledge concerning the little-known ocean. Discoveries accompany each shell expedition while explorations of this vast field are really just beginning. Our whole future existence may depend on our persistent efforts to assemble, teach, train, and guide ocean enthusiasts that they in turn may disperse the knowledge gathered from these trained amateurs. The Philadelphia Shell Club has undertaken a study to determine, if possible, an answer to the above problems.

Membership. Membership growth is apt to be rapid after the initial organization of a shell club. The trick, then, is how to keep these members coming out to meetings, taking real interest, and recruiting new members.

One of the first points to consider in trying to achieve a good attendance is finding out why people join in the first place. Some are inquisitive, just want to see what it's all about. Some already possess a few shells, wish

to learn more about them and meet others with a similar interest. Still others are recruited by existing members who hold forth on the advantages of shell collecting and "talk up" the fact that through a shell club members get reduced rates (sometimes!) on periodicals and books, lists of shell collectors for possible pen pals, dealers' offerings of exotic shells at modest cost, plus, of course, a chance to listen to lectures by real experts. It does not seem to be a problem to acquire new members.

Types of Membership and Fees. Several types of membership should be offered in order to attract local and out-of-town people (who may benefit by or be of benefit to the club), junior members, and families.

How high to set the membership fees (dues) is a problem. The cost must not be too high for what is to be offered, nor too low, else the club will go into debt. In the latter case, prospective members may feel that nothing of value can be offered for such a pittance. Also, dues as originally set should not have to be increased at a later date. The problem should be handled realistically, tied to a study of the probable future costs, then the assessment set so that no later increase will have to be made.

In the case of the Philadelphia club, a $1.00 to $2.00 fee per person per year seems to be reasonable and adequate. Regular members pay $2.00, additional members of the same family are eligible for membership for $1.00 each. Junior members (under 16 years) pay $1.00. This group *must* be encouraged in every locality, since it is from these that regular and faithful members will come in the future. And if, as happens, one of these becomes a scientist in the field because of the early interest developed by a local shell club, the purpose of the existence of the group will have been justified a thousandfold.

Corresponding members, while not able to attend regular meetings, still require postage when meeting notices and yearly proceedings are mailed. This group should be assessed at least $1.00 per year.

No provision has yet been made for Life and Honorary membership, but if the example of the American Malacological Union is followed, the former would pay $40 (20 years annual dues) and the dues waived in the case of honorary membership.

Attendance. Many factors influence attendance, such as weather, time, accessibility of meeting place, conflicting attractions such as favorite TV shows, sporting events, and social obligations. Programs must be carefully planned and varied to sound enticing to all elements among the members, no mean trick in itself.

A questionnaire sent to members may be a good way to reveal likes, dislikes, opinions on possible improvement, and individual or collective problems in need of attention. From such a study programs may be planned to insure the best possible attendance.

Except on unusual occasions or in places with large numbers of retired people, attendance of 50 to 65 percent is about standard. Increased attend-

ance figures do not always present a true picture but a close study of percentages based on attendance versus total membership cannot be disputed.

Cost of Operation. The cost of operating a shell club can vary greatly, depending on location, transportation, types of communities, simplicity or elaboration of program and activities, and a host of other factors. Meeting places may in some instances be a big cost factor. The Philadelphia Shell Club pays 16 percent of its income for meeting rooms with always the possibility of a cost increase. In some communities meeting rooms can be had without cost, and in others, where groups are small, meetings may be held in private homes.

Meeting Notices. The expense of sending meeting notices is much greater when members are notified in advance of each meeting rather than when furnished a program for the coming season. Yet, since the former procedure is felt to be a factor in ensuring maximum attendance, the Philadelphia Shell Club has adopted this practice and spends 12 percent of the annual budget on mailing costs.

Speakers should be reimbursed for time and expenses incurred in giving club members education and enjoyment; this varies from a meal and/or a small fee to transportation, lodging, and an honorarium if the speaker comes from some distance. Here we spend 19.5 percent of our annual income.

Some other cost considerations include stationery, secretary's supplies, bank charges, sales tax, rental of projection equipment and films, AMU dues (most shell clubs are affiliated with this organization), producing and distributing an annual report of club activities, maintaining a scrapbook, and providing an annual picnic. The list is not complete and the demands of other clubs may vary somewhat. Accurate records should be kept and an annual audit will then determine the financial condition of the organization. Pro-rating to the various types of memberships will show whether a preponderance of any one class is an asset or a detriment. As mentioned before, junior memberships at a reduced rate are almost certain to be "in the red," but should never be discouraged or discontinued.

The Future. Many new ideas will be investigated and some of them tried out by the Philadelphia Shell Club during the coming seasons. These will include more "shell-of-the-month" reports with possibly printed copies for distribution. There will be more club offerings of books, shells, and field trips and lists of good collecting spots near home and for use on vacation trips. A study is being made on the subject of setting aside a portion of regular or special meetings for educational purposes with certificates issued for achievements in fields such as identification, cleaning, cataloging, and possibly nomenclature. This should appeal to the young amateur.

As in the science of malacology itself, there will be no end to the seeking and the searching — and the rewards are endless, also.

UNITED STATES SHELL CLUBS

BOSTON MALACOLOGICAL CLUB, Museum of Comparative Zoölogy, Cambridge, Massachusetts

COASTAL BEND SHELL CLUB, 634 Pennington Street, Corpus Christi, Texas

CONCHOLOGICAL CLUB OF SOUTHERN CALIFORNIA, 4206 Halldale Avenue, Los Angeles, California

CONCHOLOGICAL SECTION, BUFFALO SOCIETY OF NATURAL SCIENCES, Buffalo Museum of Science, Buffalo, New York

CONNECTICUT SHELL CLUB, Peabody Museum, New Haven, Connecticut

CONNECTICUT VALLEY SHELL CLUB, Museum of Natural History, Springfield, Massachusetts

GREATER BALTIMORE SHELL CLUB, Natural History Society of Maryland, Baltimore, Maryland

GREATER ST. LOUIS SHELL CLUB, 3456 Keokuk Street, St. Louis 18, Missouri

HAWAIIAN MALACOLOGICAL SOCIETY, c/o The Aquarium, 2777 Kalakaua Avenue, Honolulu, Hawaii

LONG BEACH SHELL CLUB, 4331 Vermont Street, Long Beach, California

NAPLES SHELL CLUB, 655 Fifth Avenue, Naples, Florida

NEW YORK SHELL CLUB, American Museum of Natural History, New York City, N. Y.

NORTH CAROLINA SHELL CLUB, Fisheries Research Institute, Morehead City, North Carolina

NORTHERN CALIFORNIA MALACOZOOLOGICAL CLUB, 1027 Euclid Avenue, Berkeley, California

PACIFIC SHELL CLUB, Los Angeles County Museum, Los Angeles, California

PHILADELPHIA SHELL CLUB, Academy of Natural Sciences, Philadelphia, Pennsylvania

SACRAMENTO VALLEY CONCHOLOGICAL SOCIETY, 5349 Robertson Avenue, Carmichael, California

SAINT PETERSBURG SHELL CLUB, 3830 Seventh Street North, Saint Petersburg, Florida

SAN ANTONIO SHELL CLUB, 234 East Woodlawn Avenue, San Antonio, Texas

PALM BEACH COUNTY SHELL CLUB, 527 North "M" Street, Lake Worth, Florida

"I HEREBY BEQUEATH"

By Margaret C. Teskey

It seems fitting to close this series of articles with the plea to consider well what may become of the treasured shell collection when the collector will have finished with it. Each person who reads these lines will recall that someone he once knew owned a shell collection, and has remarked: "Whatever became of those shells, I wonder?"

The chances are that they were given to a child who evinced a passing interest, were played with until scattered and gone. Maybe they brought a few cents when the estate was auctioned off. Or they may be awaiting discovery, packed away beneath the eaves of one attic or another. In any case, if the person who built up the collection had looked ahead to the inevitable, his treasures would still be a source of pleasure or of reference, shells being the durable things that they are.

Two examples come to mind which serve to illustrate the "dos" and "don'ts" of leaving behind a collection of shells. In each case the collection came into the possession of the Buffalo Museum of Science, but the circumstances and results were vastly dissimilar.

The first collection was made by a lady during the later years of the last century and was of considerable magnitude considering that it had been built up by an amateur. When the collector died, her daughter, although totally uninterested in shells, resolved to keep the collection intact as a tribute to her mother's memory. The years passed and finally in 1950 the shells were presented in the name of the collector to the museum. Then it was that the toll of time and neglect became evident. If labels had ever accompanied the larger shells which had waited out their fate on dusty shelves, they had been lost long ago. The hundreds of lots of the smaller species had been wrapped not too well in paper upon which all data had been written in ink, now so faded as to be all but illegible. During one packing or another the brittle paper had flaked and fallen apart and the loose shells thus became valueless save as craft material in the museum's hobby division. And so it was that a very small part of the collection made with such loving care is now preserved as of any value.

The second case concerns a collection built up in over 50 years of loving care. It was somewhat smaller than the first because it was constantly being reviewed and duplicates weeded out and passed on to appreciative collectors. The owner, spurred perhaps by witnessing the fate of the other collection, made careful and detailed provisions in her will as to the disposal of her shells: "All specimens or lots which will increase the value of the collection of the Buffalo Museum of Science are to be added thereto," she directed, naming at the same time an administrator with whom she had discussed her wishes. The remaining shells she directed to be distributed to the members of the shell-study group with which she had been associated for over half a century. So by wise planning a scientific study collection has been enriched, and scores of carefully labeled shells are a constant reminder of a thoughtful friend to those she left behind.

So look ahead. You enjoy your shells, else you would not have bothered to maintain a collection. Do not allow that enjoyment to fade when other hands than yours must take over. With the ever-growing interest in malacology, school and university collections are being started all over our country. As a nucleus or addition to the new collection, a ready-made one is a bonanza indeed. You may be inspired to help rebuild a foreign collection destroyed in the ravages of war; there are many such, and any of our leading malacologists can put you in touch with deserving cases. Or a youngster may need the spur which the inheritance of a shell collection will provide and be inspired to embark upon a scientific career. But here a word of caution is in order: know the child. Be sure that he or she is genuinely interested and eager to study; every child is anxious to possess shells but in all but a few cases the interest will fade as the novelty wears away.

Unless you know that your collection contains specimens of value to the larger museums, it is best to seek your recipient elsewhere. The really large collections are likely to be helped but little by shells from the amateur's collection and the duplicates may be regarded as a nuisance rather than a benefit.

In any event, it is none too soon to reflect on what may happen to your shells unless you make your wishes known. Then act accordingly. It is later than you think!

Cheap Containers for Snails and Clams. Cabinet specimens are usually placed in trays of various sizes, as described, in the article by R. Tucker Abbott. Buying trays ready made can be expensive and making one's own and sphaeriid clams. They are too small for many Naiades, which must be kept in larger boxes or trays. Cigarette boxes are used to house the collections of Pleistocene Mollusca and for many specimens of fossils in my department. Large numbers of them will fit into trays $2\frac{1}{2}$ or $3\frac{1}{2}$ inches try using flip-top cigarette boxes for containers. They are $3\frac{1}{4} \times 2\frac{1}{4} \times \frac{7}{8}$ inches and they will hold the majority of our land and freshwater snails deep. They are labeled with strips of drafting tape stuck to the top or side trays can be tedious. If you are a heavy smoker or have friends who are, of the box, depending on the depth of the trays in which they are to be housed.—Aurele La Rocque

Method of Sorting Drift. From the superficially dried drift material, the larger bits of wood are first removed. Then the drift is boiled in a large pot for 5 minutes and cooled off by adding cold water. When the mixture is stirred, all the shells sink to the bottom because during the boiling the air was expelled from them and during the cooling the steam in them condensed. Wood and bits of plants, however, remain floating on the surface and are poured off. This process, if necessary, can be repeated by the addition of more water.—A. Tetens, *Nachr. 51*, pp. 127-128 (1919), quoted in S. H. Jaeckel, "*Prakticum der Weichtierkunde,*" Berlin, 1953. Translated by M. K. Jacobson

THE NAUTILUS

THE PILSBRY QUARTERLY
DEVOTED TO THE INTERESTS OF CONCHOLOGISTS

EDITORS AND PUBLISHERS

HORACE BURRINGTON BAKER, 11 Chelten Road, Havertown, Pa.
(Emeritus Professor of Zoology, University of Pennsylvania)

CHARLES B. WURTZ, *Consulting Biologists,*
1009 Commercial Trust Building, Philadelphia 2,

R. TUCKER ABBOTT, Henry A. Pilsbry Chair of Malacology
Academy of Natural Sciences, Philadelphia 3

$3.50 per year ($3.65 to Foreign Countries) $1.00 a copy.

MRS. HORACE B. BAKER, *Business Manager*
11 Chelten Road, Havertown, Pennsylvania